THURSDAY, AUGUST 2, 1888.

LORD ARMSTRONG ON TECHNICAL EDUCATION.

LORD ARMSTRONG, in his article in the July number of the *Nineteenth Century*, brings forward ideas which, he tells us, have long been incubating in his mind, and which he believes to be in accord with those of many employers of labour who, like himself, are engaged in manufacturing pursuits affording scope for the application of technical knowledge. A more unfortunate exposition could not have been addressed to the public at a time when so many are earnestly striving to impress upon the nation the importance of scientific training to the well-being of the people. It is not that we do not cordially agree with Lord Armstrong in many of his remarks; what we object to is the indefinite and vague character of his judgments generally, and the want of logic which characterizes many of his criticisms and recommendations: in every paragraph almost we recognize that we are reading the words of a true representative of that remarkable genus, the "practical" Englishman, who undoubtedly has been the glory of his race in the past, but threatens to be its destruction in the near future. But so outspoken a refusal to recognize the altered conditions of the times, by one who occupies the highest position among engineers, unfortunately affords clear evidence that we are making but little progress towards "organizing victory" in that great industrial war of which Huxley spoke in his memorable and incisive letter to the *Times* early in 1887, in words of deepest import, which unquestionably should serve to guide us *pace* Lord Armstrong's avowal: "As to whether our commerce is to be saved from the effects of foreign competition by a wide diffusion of technical knowledge, I have no faith in any such safeguard." In contrast with this is Huxley's emphatic warning:—"I do not think I am far wrong in assuming that we are entering, indeed have already entered, upon the most serious struggle for existence to which this country has ever been committed; and the latter years of the century promise to see us embarked in an industrial war of far more serious import than the military wars of its opening years. On the east, the most systematically instructed and best informed people in Europe are our competitors; on the west, an energetic offshoot of our own stock, grown bigger than its parent, enters upon the struggle possessed of natural resources to which we can make no pretension, and with every prospect of soon possessing that cheap labour by which they may be effectually utilized." Surely we shall elect to follow Huxley's advice offered to us in the sentence, "Many circumstances tend to justify the hope that we may hold our own if we are careful to organize victory," and we shall not be content to rely on a sufficient number of self-educated men of genius being spontaneously forthcoming to supply the nation's needs: indeed there can be no doubt that in the course of a generation or two—if we can maintain our existence unimpaired so long—every effort will be made to develop the faculties of each member of the community as fully as circumstances will permit; but unless some grievous reverse of fortune should lead the nation suddenly to realize its position, we sadly fear that the cause of educational progress has too many lukewarm adherents, holding views similar to those expressed by Lord Armstrong, for it to make much immediate progress.

Lord Armstrong says very truly that, although there is at the present time a great outcry for technical education, very few people have any distinct idea of what they mean when they use that term, or any definite opinion either as to the class of persons who will be chiefly benefited by it, or as to the time of life at which it ought to be acquired. Speaking of the meeting recently held at the Mansion House respecting the scheme for establishing Polytechnic Institutes in London, he remarks also that the speeches then delivered were rather vague and indefinite as speeches on technical education generally are; and he points out that, by using the more comprehensive phrase secondary instead of technical education, Lord Salisbury avoided the troublesome but not unnecessary task of framing a correct definition. But it may with equal truth be said of Lord Armstrong that he, like most writers on technical education, is indefinite and vague; and he also makes no attempt to give a definition of technical education. In fact, his article is nothing more than a discursive essay on the subject of popular education generally, excluding moral and religious questions.

The vagueness which characterizes the utterances of most speakers and writers on technical education is undoubtedly the outcome of the peculiarly English practice which permits men to speak with authority who have no claim whatever to be heard on the subject, and which leads us to put aside those who really are experts as of no account. The work has fallen almost entirely into the hands of philanthropists and politicians, and inquiries into the subject have been handed over to men whose qualifications for the work in too many cases would have been regarded in any other country but England as lamentably insufficient. At the recent meetings at the Society of Arts and the Mansion House there was a conspicuous absence of nearly all those who are known to have been most active in carrying on the real work of technical education and who are able to speak from experience. Yet, if the public are to be properly informed and guided, and if the politicians are to be instructed in their duties, it is imperative that others besides the ornamental and amateur members of the body of technical educators should be summoned to assist in the movement.

The *Times*, in a recent article on Lord Hartington's speech at the meeting of the Association for the Promotion of Technical Education, has very properly called attention to the importance of an accurate definition of the term technical education, pointing out that if it means that kind of education which bests fits a man both mentally and bodily for technical pursuits requiring skill and intelligence the proposition that technical education is a good thing is self-evident; but that if it means a particular method of imparting knowledge on technical subjects then it is open to many of the criticisms passed on it by Lord Armstrong. Probably the majority of the public are at present of opinion that to technically educate a youth is to teach him his business—that technical education is the modern equivalent of the now

effete apprenticeship system. This came out very clearly in the late discussion with reference to the introduction of manual training into schools, to which objection was made by many artisans, who urged, among other things, that if such instruction were given it should be imparted by skilled artisans and not by the teachers—entirely failing to realize that it was sought to introduce manual training with an educational object, for the purpose of cultivating a faculty hitherto left untrained, and not for the purpose of teaching a trade. Authorities, however, we believe, are mostly of opinion that to technically educate a youth is to teach him to understand and scientifically follow his business, and they consider that only so much of the actual practice should be learnt by the student who is being technically educated as will suffice to afford the necessary insight into the principles on which the practice is founded. Thus, medical men have long been technically educated: they have not only learnt the practice of their profession, but have also devoted a large amount of time to the study of the facts and scientific principles on which medical practice is based, and the demands upon them in this latter direction have been much increased within recent years. Engineers and architects, on the other hand, hitherto have generally not been technically educated: entering the workshop or office, they have been left to acquire as they best might a knowledge of the scientific principles underlying their professions, their attention having been almost entirely devoted to acquiring manipulative skill and a knowledge of constructive details.

It is difficult to understand what meaning Lord Armstrong attaches to the term technical education. He tells us that the question "What is the use of useful knowledge?" appears to him to present in a quaint form a theme of a very debatable nature! He then proceeds to argue that success in the world depends on the possession of genius; knowledge—well, is of no particular consequence! "Many people imagine that genius is kept down from want of knowledge, and that in many cases it is thus lost to the world. This I entirely dispute. Genius is irrepressible, and revels in overcoming difficulties." But even the genius must find his opportunity, and—nowadays at least—must be possessed of sufficient knowledge to be able to take advantage of the opportunity when found. Moreover, as the world progresses, opportunities are not found to be increasingly numerous in proportion to the growth of the population, nor do the problems diminish in difficulty; and no reliance can be placed upon the supply of genius keeping pace with the demand.

Lord Armstrong thinks that the well-known dictum that if the Romans had had to learn Latin they never would have conquered the world, is suggestive of what our loss might have been if self-made engineers such as Watt, George Stephenson, Smeaton, Brindley and Telford, had frittered away their energies upon inappropriate studies forced upon them at school; and that generals such as Wellington and Marlborough, or naval commanders such as Nelson and Blake, would not have directed the armies and navies of England with more effect if book knowledge had been crammed into them at school. But to argue in this manner is to entirely pervert the theme of technical education: the whole object of its advocates being so to improve the entire educational machine that all inappropriate studies may be eliminated from the school course, and every provision made for developing and strengthening the faculties generally; and even Lord Armstrong admits that as "cheapness of production and superiority of quality will decide the victory in the race of competition, we shall improve our chance of maintaining a foremost place if by early training we develop the mental and bodily faculties of our people." His subsequent words, however, "but not, I think, by any forced or indiscriminate system of imparting knowledge," are simply incomprehensible, as no one has suggested the introduction of any "forced and indiscriminate system"; in fact, this is only one of the many cases in which Lord Armstrong sets up an image of his own creation, and at once hastily destroys it. When he tells us that he does not "undervalue technical knowledge voluntarily acquired as a means to an end, but it is the brain-workers and not the hand-workers who will seek to attain it and benefit by it," he entirely overlooks the fact that one great object of technical education is to associate brains with hands and hands with brains.

We have no space left to discuss Lord Armstrong's extraordinary views with reference to existing facilities for the acquisition of technical knowledge and their sufficiency. But we must call attention to his contention "that when Colleges can be established by public subscription or private munificence, they are worthy of approval and commendation; but where the State or local governing bodies have to furnish money for education in relation to national industry, they must look to attaining the required results at the least possible expense, and I am inclined to look upon Colleges as luxuries in education rather than necessaries." In marked contrast to this is a statement made by Sir Henry Roscoe in the discussion on Mr. Swire Smith's paper on the Technical Education Bill, read at the Society of Arts in February last. Speaking of what the Swiss were doing, Sir Henry related how, a few years ago, when it was proposed to spend £24,000 on the erection of a new chemical department of the Zurich Polytechnicum, some of the Bundesrath were a little startled and rather objected to paying so large a sum, and there was accordingly in Berne some opposition; but the Minister of Education pointed out that the amount of money which had already been received by Switzerland from the men who had studied in the Polytechnic School at Zurich had amounted to ten times over the sum he was asking for, and he was sure that the money would be well spent, and in a short time recouped. The Swiss, at all events—let alone the Germans—therefore do not look upon Colleges as luxuries rather than necessaries; and we are assured that if comparison were made of the work done by chemists in Swiss laboratories with that done by English chemists, the result would not be to the credit of our country. We should like Lord Armstrong to tell us—is he, or is he not, content to see this country remain on a lower intellectual footing than Switzerland?

Great as is Lord Armstrong's reputation as a mechanical engineer, we trust that few will regard him as an "unimpeachable authority" in the matter of technical education: if the majority remain much longer of his opinion, then is the fate of our nation sealed.

EXPLORATIONS AND ADVENTURES IN NEW GUINEA.

Explorations and Adventures in New Guinea. By Captain John Strachan, F.R.G.S., F.R.C.I. (London: Sampson Low, Marston, Searle, and Rivington, 1888.)

THE *terræ incognitæ* of the world are year by year growing less; but of these the vast island continent of New Guinea remains as to much of its coasts, and almost all of its mountain regions, still scantily known and explored. The elegantly bound volume under review is the latest contribution to our knowledge of the shores of this tripartite country. To the explorer who adventures himself into this most insalubrious territory, even if he bring back with him but small additions, we are under a debt of gratitude, if so be, however, that his record be trustworthy, and an honest attempt to add to science geographical or biological.

Captain Strachan is a master mariner, who appears to have spent several years on the New Guinea coasts, in command of small trading vessels, engaged in the collection of such commercial products as are to be obtained from the natives, and has made a bid for fame by combining with his ordinary pursuits the *rôle* of explorer. The narrative before us it would be unfair to submit to too rigid a criticism as a literary production, especially as the author disclaims the intention of aspiring to "literary renown," but relates his experiences in the "homely language of a British sailor." Deprived of the expectation of a literary delicacy, the reader has a right to hope for a more or less satisfying portion of new facts and observations, as the *raison d'être* of the work.

The book divides itself into two portions: explorations in the Papuan Gulf within the British Protectorate; and in Macluer Inlet (or Gulf, as Mr. Strachan not inappropriately calls it) in the Dutch territory in the north-west.

In the Papuan Gulf, Mr. Strachan claims to have ascended the Mia Kasa river, and to have discovered and explored Strachan Island and Strachan Country, a region lying to the immediate west of the Fly River. He has discovered also a large arm of the Mia Kasa, christened by him the Prince Leopold River, which incloses, and is the western boundary of, Strachan Island. The name, Prince Leopold River, he has applied also to the Mia Kasa above its junction. Beyond the mere statement, "the Mia Kasa itself was discovered by Dr. Samuel Macfarlane as far back as 1877, and was named by him the Baxter," Mr. Strachan makes no reference to the previous exploration of the river made, not in 1877 but in 1875, by that missionary, who ascended it for sixty miles in the *Ellengowan* steamer, and for thirty miles farther in one of his ship's boats. This is as far as, if not farther than, the point attained by Mr. Strachan. If therefore a new name had to be applied, only the western arm, now first brought to our knowledge, ought to bear the name Prince Leopold, while the river explored by Mr. Macfarlane should be known as the Mia Kasa or Baxter. Even the Prince Leopold River is indicated in Macfarlane's map. Mr. Strachan has indicated a number of diverticula extending right and left from both rivers, but he adds little, beyond stating it, to the opinion, long held, though yet without absolute proof, that the Mia Kasa and all its affluents are merely canals of the vast delta system of the Fly River. If Mr. Strachan had taken the trouble to examine the work of his predecessors, he could scarcely have deluded himself on entering the mouth of its estuary with such fancies as these: "During the whole day I could not help thinking that we were not sailing on a river at all; but were on an arm of the sea, which would, in all probability, extend across the whole island from south-east to north-west, opening into the Arafura Sea at that part known to the Dutch as the Utanata River; and I built a good many castles in the air in consequence, hoping we had found a new channel to China and the East"! It is sufficient to state that the Utanata River rises in the gorges of the Charles Lewis Range, so that the water-way surmised by Mr. Strachan to exist must cross the spurs of that range. Nor has he any better basis for many of his beliefs, none of which appears more unfounded than that given on p. 278, where a river "debouching into the Arafura Sea opposite Providential Bank, will, I believe, be found connected with the Fly River at its junction with the Alice River, discovered by D'Albertis"! This new river would necessarily bisect his new channel to China! We have unfortunately no means of testing the accuracy of the author's positions. He does not tell us on what base his survey is constructed; or whether it is established by astronomical observations, or from assumed points on the Admiralty chart fixed by sextant angles or prismatic bearings, so as to gain his reader's confidence in his discoveries. On p. 41 he refers to a large tributary as being "ninety miles inland which I named the Wallace"; while on p. 128, he says, "at a distance of some *eighty* miles the Prince Leopold again divides into two branches, the eastern of which is the Wallace," "which we followed [p. 42] for a distance of seventy miles through the same class of country." If we test this distance by his map, we find that a chain thirty-five miles in length, would extend from the mouth of the Wallace River to *beyond* the Fly River. These discrepancies do not increase our confidence in the accuracy of Mr. Strachan's explorations. He describes the country in this region in the most glowing terms, "splendid agricultural country," "well watered," "high land." Other travellers have reported it as "low and swampy," while D'Albertis in ascending the Fly, found the whole country for some hundreds of miles low and little elevated above the sea. Such glowing advertisements are to be gravely deprecated, of a region so malarious that few Europeans can ever be able to settle in it as their home; it is doubtful whether they could even find it habitable during the wet season. While abundance of unoccupied territory exists in Australia, richer in soil and easier of access, and in a far less unhealthy climate, no wise man will risk his capital and his life in the great delta of the Fly River. The natives at the mouth of the Mia Kasa seem to have so threatened the little party, that they had to abandon their lugger, and make for the coast overland, experiencing some hardships by the way, and eventually the loss of one of their companions by drowning. We fear few will be able to appreciate Mr. Strachan's delicacy in forbidding, "in order to prevent raising a hostile spirit among the natives," his "weary, worn and starving people," from cutting down a cocoa nut tree, during their retreat, shortly after they had been firing on its owners with their Winchesters, discharging rockets in

their midst, and exploding among them a tin case containing twenty-five pounds of gunpowder. One would think that if their hostility had not been excited by these gentle tactics, they could have borne also with equanimity the appropriating of a few cocoanuts.

The second part into which this record of exploration divides itself, is really little more than the log of a trading cruise. Except the claim to the differentiation of a few insignificant islands, no piece of exploration worthy of the name abides in the recollection after laying down the volume. Macluer Inlet has long been a *rendezvous* for trading vessels, and Mr. Strachan's time seems to have been chiefly devoted to collecting nutmegs, massoi bark, tortoise- and pearl-shell from the natives. He reached the top of the Gulf, and he lays evidently great store by another geographical surmise related in the following words:—

"In three days we arrived at the head of the Gulf and anchored opposite what afterwards proved to be an island. Here two channels, one to the north and the other to the south, debouch into the inlet. The latter we entered and followed until we reached a bend, at a distance of not more than three miles from Gleevink [Geelvink] Bay, where we anchored.

"Here the channel is between two and three miles in width, and the depth of water seven fathoms. My charts showed the opposite shore to be entirely unsurveyed and faced by many islands; the inhabitants of which I had reason to believe were hostile.

"These considerations decided me to return, although well convinced that by continuing another two or three miles I should enter the broad waters of Gleevink [Geelvink] Bay."

We should have felt more confidence in this conviction, if the author had given the data on which he grounds his surmise, if only to allay our suspicions that this is not a happier guess than that which flashed on him at the mouth of the Mia Kasa River. He makes no reference to the explorations in 1873, in the same region, of Dr. Meyer, who, entering the Wapari River on the eastern side, in Geelvink Bay, and ascending mountains over 1200 feet in height, descended the western slope till he struck the Jakati river by which he reached the shores of Macluer Inlet—a route which must have led him across the wide channel supposed by Mr. Strachan to exist, but of which no mention is made by Dr. Meyer. Is Mr. Strachan *quite sure* about his position—especially the longitude of his turning point?

In the selection of his crews Mr. Strachan was most unfortunate. They appear to have been very typical beachcombers, against whom he brings charges of threatening the natives, and of wantonly shooting their dogs—deeds which are very characteristic of that baneful type of humanity.

In his natural history determinations Mr. Strachan is very often considerably afield; but he makes several interesting observations on the customs of the people. One or two illustrations of the natives are given, which appear to be faithful representations of the tribes of the delta.

The book, we regret to say, does not leave a very satisfactory impression on the reader; there are numerous inaccuracies and too many discrepancies between the text and the maps; while the goody-goodyism and buccaneering brag with which it is interlarded are insufferably nauseous, with the result that the reader loses what confidence he might otherwise have had in statements of the author that may be quite accurate.

In noticing this volume we cannot omit to draw attention to a subject much more serious than its poverty of fare. Mr. Strachan tells us he was denounced in New South Wales as a "red-handed murderer, who had tramped through New Guinea knee-deep in blood." The accusations against him were the outcome of the "outrageous lying" of one of his own party, which he rebutted by a letter to the Secretary of State for the Colonies, who caused his (Mr. Strachan's) letter to be published in Sydney for general information. We may probably accept the statements made against himself in this volume, under his own hand, as at least not "outrageous lying." Mr. Strachan knew fully the conditions under which he and his party had permission to cruise in the waters of the Protectorate or of the Dutch Crown. No spirits, firearms, gunpowder, dynamite, or any explosives can be landed under any circumstances, so as to be given or sold to the natives; no acquisition of land on any account is permitted; and above all a just treatment of the natives is a *sine quâ non*, since it was the overacts of her subjects that compelled Her Majesty to take under her gracious Protection the inhabitants of that portion of Papua, now generally known as British New Guinea, and for which the name of Torresia has been suggested. On p. 80 is recorded this little episode: "The men who were so fortunate as to possess muskets were very eager to obtain ammunition; but this the law distinctly forbids the white man either to give or to sell to the natives under a penalty of three months imprisonment. . . . . Being anxious to accommodate those whose kindness to me had been so uniform, I was placed on the horns of a dilemma, but having confidence in their integrity, and being anxious to serve them while keeping within the strict letter of the law [! ! !] . . I at last decided to place the required ammunition on my cabin table. Having done this I lit my pipe, and went on deck to give some orders to my officers. On my return the natives had all left my cabin. . . . I missed a twenty-eight pound bag of No. 4 shot, half-a-dozen half-pound flasks of powder, and a box of caps." This is not the only occasion, recorded in his book, on which he distributed warlike material. In several places he confesses to having dispensed gin to the natives, and presented it as gifts to chiefs. The edict as to the purchase of land was also disregarded in the same open way. He purchased Strachan Island, containing [only] seven hundred and fifty square miles, by a very simple transaction. "'Are you willing that I come and possess this island?' . . . . They all signified their willingness. My trade was opened and parcelled out to each chief according to the number of people in his tribe. I told them the name was Strachan Island, and by this name the natives know the island at present." The latter amazing statement we may take for what it is worth; but it would have been very instructive to have had details of the items of the trade paid for this little estate. The document would probably have formed a companion to the valuable inventory given in the late Sir Peter Scratchley's journals of the price paid by certain Australian pioneers for a tract of land the size of a large English

county. There is no evidence that these "chiefs" owned the land they were selling, nor that they were made aware that they were parting for ever with their most cherished possessions, of which Mr. Strachan attempted to claim ownership (Her Majesty's edict notwithstanding) in right of exploration and purchase. While in Macluer Inlet, the author resided among a people who spoke to some extent the Malay language. The quotations with which we are favoured in his book, not to mention his own admission of the fact, show clearly how imperfect his knowledge of that language (as of the true language of the region) is. Yet from a conversation he overhears, half of which only, he admits, he understood, he accuses certain chiefs of Macluer Inlet of slave-hunting, and in the most high-handed and unauthorized manner, carries them off prisoners to Gessir, to give them in charge to the Dutch authorities, yet does not do so (owing to stress of weather), which under the grave circumstances he ought to have done when the weather moderated. Eventually, after severe cogitations whether he should not himself inflict punishment on them, he returns them to their homes, when he feels "much lighter of heart." Shortly after this, he sees a canoe "dodging backwards and forwards among the islands within gun shot of the ship," and is seized with a panic (as he often was), and without the flimsiest evidence of a hostile intention on the part of its occupants, he seized a "long range rifle" and fired into it; "they then began paddling rapidly, and although I fired many shots I could not round them to." Nor are these again the solitary instances of most illegal acts performed by Mr. Strachan as recorded by himself. It is doubtful, also, whether the removal of the little lad whom he brought from his country to England (and whom he appears to have treated with the greatest possible kindness) was not an act of kidnapping. Altogether, it is perhaps not surprising that the natives, as Mr. Strachan bemoans, "cannot recognize nor appreciate the principles of honesty and honour," so exemplified.

Her Majesty's Special Commissioner comes in for a most violent and unwarrantable attack. No one who reads Mr. Strachan's own admissions will wonder that his explorations were not regarded by the authorities with all the favour he could desire. If Mr. Douglas had had the facts here recorded before him, he must, we fear, instead of renewing the author's permit, have excluded him from again approaching the island. The Commissioners administering the Government in New Guinea have had experience enough of the woes that flow not to the natives themselves only, but to unsuspecting Europeans who have the misfortune to follow behind (and have paid, too often, the penalty of the overacts of) such explorers as "Captain" John Strachan.

MINE-SURVEYING.

A Treatise on Mine-Surveying. By Bennett H. Brough, F.G.S., F.I.C., 8vo., pp. 282 with 101 woodcuts, two appendices and index. (London: Charles Griffin and Co., 1888.)

MR. BROUGH, who for many years has been giving instruction in surveying at the Royal School of Mines, has placed the mining world under a debt of gratitude to him by the issue of his compact manual. It is the kind of book which has long been wanted, and often asked for, not only by mining students, but also by mine-agents desirous of obtaining more knowledge concerning a material branch of their profession.

The book is divided into nineteen chapters. In the first the author dwells upon the importance of mine-surveying and certainly does not exaggerate it. Instances could be multiplied showing the danger to life and the loss of valuable mineral from the want of accurate plans. A blot in British legislation does not escape the author's notice, and he very properly regrets that the agents of ordinary ore-mines are not required to qualify themselves by examination in the same way as their brethren at collieries. Considering that the tin miners of Cornwall have a rather higher death-rate from accidents than colliers, and a very much higher death-rate from diseases induced by their occupation, it does seem strange that the test of ability imposed in one case should be entirely dispensed with in the other. When the Metalliferous Mines Regulation Act is amended we may hope to see this anomaly swept away Many agents of ore-mines would welcome the introduction of certificates of competency, because a Government diploma would raise their status at home and constitute a valuable passport for them abroad.

Four chapters are devoted to surveying with the ordinary miner's dial, of which various forms are described; and very useful hints are given concerning sources of error with the magnetic needle, which would not strike tyros, and some of which are probably unknown to many practised surveyors. The important question of the diurnal and secular variation of the magnetic needle is next fully dealt with, and we hope that due heed will be paid to Mr. Brough's remarks, for few ordinary diallers are aware that the needle may vary 10′ from 8 a.m. to 1 p.m.

The theodolite is properly recommended for cases where great accuracy is required, and much useful information is afforded upon various matters, such as plotting, calculation of areas, levelling, connection of underground and surface surveys and methods of rapid surveying with the tacheometer. Faults and subsidences are discussed at length, and careful directions are given concerning the construction and copying of mine plans. Mr. Brough insists upon neat lettering, but curiously enough omits all mention of stencil plates for this purpose.

The last chapter, dealing with the application of the magnetic needle in mining, is full of interesting matter. We have good descriptions of the Swedish and American dip-compasses, and the improved methods of Brooks, Thalén and Tiberg, for exploring for iron ore; and the author exposes the clever devices of unscrupulous mine-sharks for misleading intending purchasers. Between the years 1868 and 1875 eighty-five iron mines were discovered in the State of New Jersey solely by the magnetic needle, and in many cases where there was no visible indication of ore at the surface.

Mr. Macgeorge's ingenious appliances for ascertaining the true direction taken by bore-holes, which frequently deviate very considerably from the vertical, attracted much attention at the Inventions Exhibition, where they received a gold medal. Now that Mr. Macgeorge's

method is described in a text-book, its advantages will become more generally known.

Mr. Brough deserves much praise for the care with which he has searched European and American publications so as to bring his work up to date, and there is little call for censure save upon minor points which do not affect the general value of the text-book.

It is time that some one should enter a protest against two of the technical terms defined by the author, and frequently met with in the reports of mining experts, viz. "country rock" and "gangue." To say "country rock" is tautology. The word "country" alone, as used in Cornwall, means "surrounding rock" or "enclosing rock," and, if the provincialism is to be adopted, there is no necessity to add the word "rock." The word "gangue" is objectionable, because it has come to us through Frenchmen, who apparently did not thoroughly understand the meaning of the German word "Gang." "Matrix," "lodestuff," and "veinstuff" are better words than "gangue," which might well be allowed to drop out of mining books, especially as it is rarely heard at mines.

To cite the china clay deposits of Cornwall as examples of *stockworks* is unfortunate, because the occurrence in them of veins bearing workable quantities of tin ore is the exception, not the rule.

In Chapter VIII. Mr. Brough says: "In 1798 Breithaupt, of Cassel, invented a mine-surveying instrument, which he called an *astrolabium*." This remark is not correct, for, as the author well knows, the astrolabe was invented by the ancients. The statement should have been that H. C. W. Breithaupt was one of the first to put an astrolabe upon a stand and use it for surveying underground. According to Mr. Brough the theodolite has been employed more or less for mine surveys since 1836. This date is probably correct as far as Germany is concerned; but as a matter of fact a mining theodolite was supplied to the Imperial Brazilian Mining Association four years earlier.

The description of Prof. Borcher's method of using magnets for ascertaining the precise line in which one should continue to work in order to connect two drivages in opposite directions which are approaching each other, is not so clear as it ought to be. Mr. Brough omits to explain, in reference to Fig. 101, that by construction the points A, B, and C are situated upon the circumference of a circle, the centre of which is E; and the confusion is increased by the statement that the triangle A E C is "equilateral," whereas it is really only isosceles. The consequence is that the reader is very much puzzled.

However, these and a few other errors can easily be corrected in a second edition, which is likely to be required before many years are past; because, as soon as the book becomes known, no English-speaking mine-agent or mining student will consider his technical library complete without it. C. LE NEVE FOSTER.

OUR BOOK SHELF.

Charles A. Gillig's Tours and Excursions in Great Britain. By Stephen F. Smart. (London: United States Exchange, 1888.)

THIS book is intended in the first instance for Americans, but it may also be of some service to English tourists. Taking London as a central point—"not only because it is the most notable city of the world, but because it is the Mecca, if not the El Medina, of trans-Atlantic tourists, at least"—the author describes a series of excursions, any one of which will well repay the trouble of those who may elect to follow his guidance. He also describes various tours in Wales and Scotland. Mr. Smart has been at pains to make himself familiar with the ground over which he undertakes to lead others, and the information he presents, so far as we have been able to test it, is thoroughly trustworthy. Of course, no one who wishes to obtain a full account of any particular town or district will think of consulting this little book. But as a general sketch, it has considerable merits; and it will doubtless help many American visitors to make the most of a brief visit to Great Britain.

LETTERS TO THE EDITOR.

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The Supply of Bait for Sea-Fishermen.

ONE of the first questions of practical importance with which the Marine Biological Association has to deal is that of supplying the long-line fishermen with a continuous supply of bait at a cheap rate. Great distress is often occasioned through fishermen being unable to get the necessary bait for their long lines. Mr. Robert Bayly, of Plymouth, a governor of the Marine Biological Association, has generously given a sum of £500 to be spent on investigations on the bait question, and the Council have instructed me, as Director of the Association, to consider the best means of spending this sum. I shall therefore be glad to receive any suggestions from gentlemen who may interest themselves in this question, or to consider the work of any investigator already in the field, with the view of employing a suitable person to carry out a series of observations and experiments.

Two methods appear to offer a solution to the question. Either the animals used commonly as bait, such as whelks, mussels, and squid, may be reared artificially and kept in confinement till required, or some artificial bait may be invented which will lure the more valuable kinds of fish to the hook.

The former of these methods has been successfully practised in France, but such is the operation of the English laws on shore fisheries that there is very little prospect of its being possible in England, unless those laws are altered.

The second method, though more apparently difficult, is the more likely to attain success. Fish are undoubtedly guided by smell and taste in the selection of their food. Some are known to be very nice about the kind of food offered to them, and will only take certain kinds of bait. The whelk is a very favourite morsel, and has a distinct smell and taste: it may be possible to determine by analysis the essential oil or whatever it may be that gives this odour, and to imitate it sufficiently well to deceive the fish. The trade is able to imitate successfully the bouquet of wines: cannot chemistry produce an imitation of the bouquet of the whelk? G. C. BOURNE.

The Laboratory, Citadel Hill, Plymouth, July 31.

Geometric Meaning of Differential Equations.

IN the Proceedings of the Royal Asiatic Society of Bengal, 1888, p. 76, Prof. Asutosh Mukhopadhyay has proposed a really excellent mode of geometric interpretation of differential equations in general: viz. writing the equation in form F = 0, the geometric meaning of the symbol F considered as a magnitude (angle, line, area, &c.), *in any curve whatever* (wherein F is of course not zero), is, if possible, to be formed; then the geometric meaning of that equation obviously is that the quantity F vanishes right round every curve of the family represented. This is the most direct geometrical interpretation yet proposed.

Three examples have been given by him, all very neat. Writing for shortness the differential equations thus—

Circle, R = 0; *Parabola*, S = 0; *Conic*, T = 0,

he has proved (in Journ. As. Soc. Bengal, vol. lvi. p. 144, and NATURE, vol. xxxviii. p. 173) that in general *in any curve* whatever,

(1) Tan. ∠ of aberrancy = q_1. R;
(2) Index of aberrancy = q_2. S;
(3) Radius of curvature of aberrancy curve = q_3. T;

where q_1, q_2, q_3 are certain functions in general finite. Hence the geometric meaning of the differential equations of the three curves is at once

(1) *Circle.*—Angle of aberrancy = 0
(2) *Parabola.*—Index of aberrancy = 0
(3) *Conic.*—Radius of curvature of aberrancy curve = 0
} right round all curves of each family.

The verbal neatness of these interpretations can hardly be excelled.

A writer (R. B. H.) in NATURE, vol. xxxviii. p. 197, objects to the last that it really only means that *a conic is a conic* (because its aberrancy curve shrinks into the centre)! Now, this is precisely what was to be expected: the differential equation of a curve expresses *exactly* that the curve of some family which osculates it in the highest degree is *the curve itself.* But the new interpretation puts this in a neat form, viz. in assigning a *meaning* to the magnitude F, which differs from zero in general, and whose vanishing at all points of every curve of a certain family (say conic) indicates a property of high generality of those curves.

But the Professor makes, what I conceive to be, the mistaken claim (Proc. As. Soc. Bengal, 1888, p. 75, *et seq.*), that this mode of interpretation is the *only true one;* and further that, accepting this mode of interpretation, *only one meaning* can be attached to it (p. 76, l. 29, *op. cit.*).

Now it must be observed that the equation F = 0 implies *directly*, not only that some one geometric magnitude F vanishes, but also that every geometric magnitude vanishing with F (such as *a*F, *a*F^m, *sin*F, &c.) vanishes right round every curve of the family. All of these are equally good geometric interpretations *of the same kind* as proposed.

But the equation F = 0 also implies, more or less directly, countless theorems of position, osculation, &c. All of these may be fairly considered geometric meanings of that equation. Thus, attending to the meaning of "aberrancy," the results quoted involve directly—

(1) *Circle.*—Normal coincides with diameters.

(2) *Parabola.*—Diameters are axes of aberrancy, and meet at infinity.

(3) *Conic.*—Diameters are axes of aberrancy, and are concurrent (in the centre).

Surely these are also *true* geometric interpretations.

Lastly, let the equation F = 0 be multiplied by any of its integrating factors μ, and write for shortness $\int \mu F dx = \phi$. It follows that ϕ = constant. Hence, since the number of integrating factors is infinite, another (indirect) geometric interpretation arises, viz. that all the geometric magnitudes ϕ are constant right round every curve of the family.

These latter *general* modes of interpretation, viz. theorems of position, osculation, and of first integrals ($\phi = c$), I had given eleven years ago (in *Quart. Journ. Math.*, vol. xiv. p. 226).

To the last of these the Professor has objected (p. 76 of his paper quoted), that it is not an interpretation of the equation F = 0 at all, but only of its first integrals $\phi = c$. This is, of course, admitted. But it is worth noting that the connection between the two, F = 0, $\phi = c$, is so very close, that many will accept an interpretation of the latter as a fair (indirect) interpretation of the former also.

In fact, since F = 0 is equivalent to $D_x\phi = 0$, the former is now seen to mean *directly* that there is no variation of any of the magnitudes ϕ right round every curve of the family; and this is a strict *direct* interpretation of the equation F = 0 itself. But many will probably prefer the shorter phrase ϕ = constant, even though it interprets F = 0 only indirectly.

There is, moreover, a *slight* disadvantage in the former mode of interpretation, viz. that the meaning of the magnitude F must necessarily be sought in curves other than, and *usually more complex* than, the curves denoted by F = 0; whereas the interpretation of $\phi = c$ only requires the finding a meaning for ϕ, which is explained in my paper quoted to be any fundamental geometric magnitude *of the curve itself.*

ALLAN CUNNINGHAM, *Lt.-Col., R.E.*

British Earthworms.

THE occurrence of any new animal in England is a point of some interest, however humble that animal may be; and, in order to work out the species of British earthworms, I sent a letter to the *Field* some time back, requesting readers of that journal to forward me specimens. In reply I received a large number of worms from various people, amongst them being Mr. F. O. Pickard Cambridge, of Hyde, who has very kindly sent me several parcels of worms. One of these parcels contained some very fine gravel taken from the bed of a stream, together with a number of small worms about 1½ to 2 inches in length. These turned out to be a species of *Allurus*, a genus formed by Eisen for a worm in which the male pores are on the thirteenth segment instead of on the fifteenth, as in the other genera of the family Lumbricidæ. Only one species is at present known, viz. *A. tetraëdrus;* it is of a beautiful sienna colour, with a dull orange clitellum.

I wish to record, for the first time, its occurrence in England, and also to draw attention to the fact that it lives below water, at any rate for some part of the year. Mr. Cambridge has been most obliging in giving me the facts as to the place in which he found the worms: they occur in the gravelly bed of a stream which at certain times of the year runs down so low as to leave small gravelly islands 2 or 3 inches high. In these islands he found *Allurus;* but he finds none in the banks of the stream. We already know of *Criodrilus* as being a thoroughly aquatic earthworm, living in the muddy beds of rivers and lakes; and although this worm has not yet been recorded in Great Britain, I see no reason to doubt that it exists here.

I should add that Mr. Beddard has informed me that he received a specimen of *Allurus* from Lea, Kent, some time after I received these from Hyde. It has been recorded also from Sweden, Italy, and Tenerife. WM. B. BENHAM.

University College.

THE SUN MOTOR.

INDIA, South America, and other countries interested in the employment of sun power for mechanical purposes, have watched with great attention the result of recent experiments in France, conducted by M. Tellier, whose plan of actuating motive engines by the *direct* application of solar heat has been supposed to be more advantageous than the plan adopted by the writer of increasing the intensity of the solar rays by a series of reflecting mirrors. The published statements that "the heat-absorbing surface" of the French apparatus presents an area of 215 square feet to the action of the sun's rays, and that "the work done has been only 43,360 foot-pounds per hour," furnish data proving that Tellier's invention possesses no practical value.

The results of protracted experiments with my sun motors, provided with reflecting mirrors as stated, have established the fact that a surface of 100 square feet presented at right angles to the sun, at noon, in the latitude of New York, during summer, develops a mechanical energy reaching 1,850,000 foot-pounds per hour. The advocates of the French system of dispensing with the "cumbrous mirrors" will do well to compare the said amount with the insignificant mechanical energy represented by 43,360 foot-pounds per hour developed by 215 square feet of surface exposed to the sun by Tellier, during his experiments in Paris referred to.

The following brief description will give a clear idea of the nature and arrangement of the reflecting mirrors adopted by the writer for increasing the intensity of the solar heat which imparts expansive force to the medium propelling the working piston of the motive engine. Fig. 1 represents a perspective view of a cylindrical heater, and a frame supporting a series of reflecting mirrors composed of narrow strips of window-glass coated with

silver on the under side. The frame consists of a light structure of wrought iron or steel, provided with transverse ribs as shown by the illustration, each rib being accurately bent to a parabolic curvature whose focus coincides with the axis of the cylindrical heater. It needs hardly be stated that the mirrors supported by the said transverse ribs continue from side to side of the frame, which accordingly resembles a parabolic trough whose bottom is composed of mirrors. It will be readily understood that this trough with its bent ribs and flat mirrors forms a perfect parabolic reflector, to which a cylindrical heater, as stated, may be attached for generating steam or expanding the gases intended to actuate the piston of the motive engine. Regarding the mechanism for turning the reflector towards the sun, engineers are aware that various combinations based on the principle of the "universal joint" may be employed.

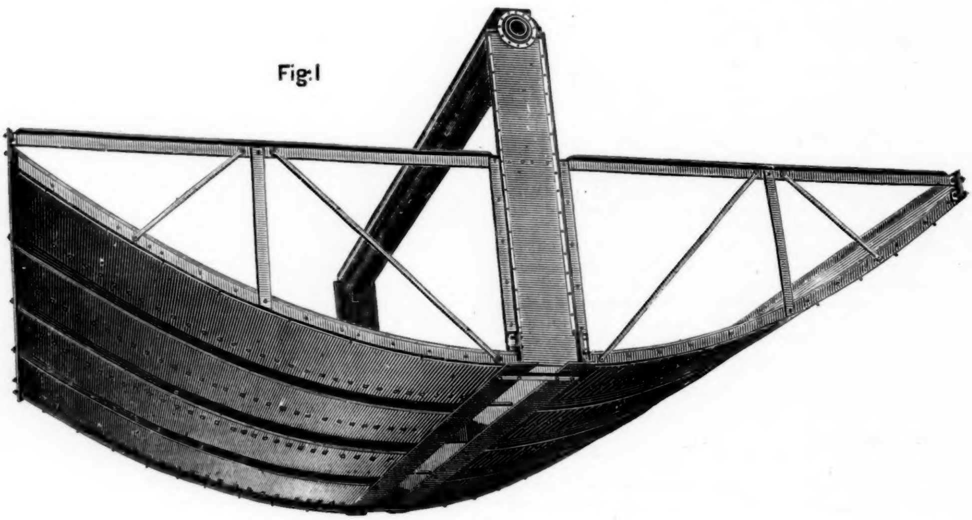
Concerning previous attempts made in France to utilize solar energy for mechanical purposes, it is well known that practical engineers, having critically examined Mouchot's solar engine, which M. Tellier proposes to supersede, find that it is incapable of developing sufficient power for any domestic purpose. Again, the investigations carried out by order of the French Government to ascertain the merits of Mouchot's invention show that irrespective of the great expense of silver-lined curved metallic reflectors for increasing the insufficient energy of direct solar radiation, these reflectors cannot be made on a sufficient scale for motors having adequate power to meet the demands of commerce; nor is it possible to overcome the difficulty of rapid wear of the delicate silver lining of the metallic reflectors consequent on atmospheric influence, which after a few hours of exposure renders their surfaces tarnished and ineffective unless continually polished. A glance at the accompanying illustration (Fig. 1) shows that the reflector constructed for my sun motor differs altogether from that originated by Mouchot, which Tellier's apparatus, tested at Paris, was intended to displace.

Description of the Illustrated Reflector.

(1) The mirrors which reflect the solar rays are devoid of curvature, being flat narrow strips of ordinary window-glass, cut to uniform width and length, perfectly straight.

(2) The under sides of said strips are coated with silver by a process which prevents the action of the sun's rays from destroying the silver coating as in ordinary looking-glasses.

Fig. 1



(3) The mirrors supported by the bent metallic ribs extending from side to side of the parabolic trough, are held down by the heads of small screws tapped into the ribs. Thin slats of wood may be introduced between the mirrors and the ribs—an expedient of some importance in localities where the reflector is exposed to high winds.

(4) It needs no explanation that the *reflecting surface* of the mirrors cannot become tarnished by atmospheric influence, since the bright side of the silver coating is permanently protected by the glass; hence it will be only necessary to remove *dust* from the mirrors, an operation readily performed by feather brushes secured to light handles of suitable length.

(5) The frame of the reflector, being composed of rolled bars of iron or steel, requires no finish, excepting the top of the transverse ribs, which must correspond accurately with a given parabolic curvature. It should be observed that the needed accuracy is readily attained by a cutting tool guided by a bar of proper form.

(6) Regarding cost of construction, it will suffice to state that manufacturers of glass, both in the United States and Germany, supply the mirrors, cut to exact size and silvered, at a rate of 60 cents. per square foot, the weight being 106 pounds per 100 square feet. Consequently the cost of the reflector and heater for the sun motor will not much exceed that of a steam boiler and appurtenances, including chimney. The cost of the engine apart from the reflector, will not be greater than that of an ordinary steam-engine.

(7) With reference to durability, it will be evident that the light metallic frame with its mirrors, and a heater acted upon only by reflected solar heat, will last much longer than steam boilers subjected to the action of fire, soot, and corrosion.

Let us now briefly consider the distinguishing feature of the sun motor—namely, the increase of the intensity of the sun's radiant energy by *parallel* rays and *flat* reflecting surfaces permanently protected against atmospheric influence. It has been supposed that the lens and the curved reflecting surface, by converging the sun's rays, could alone increase the intensity of radiant heat. But Newton's demonstration, showing that the temperature produced by solar radiation is "as the density of the

rays," taught me to adopt in place of curved surfaces and converging rays, flat surfaces and parallel rays, as shown by Fig. 2, which represents a transverse section of part of the reflector. The direct vertical solar rays, it will be seen, act on the mirrors; while the reflected rays, divided into diagonal clusters of parallel rays, act on the heater, the surface of which will thus be exposed to a dense mass of reflected rays, and consequently raised to a temperature exceeding 600° F. at noon during ordinary sunshine.

The cost, durability, and mechanical energy of the sun motor being thus disposed of, it remains to be shown whether the developed energy is continuous, or whether the power of the engine changes with the increase and diminution of zenith distance and consequent variation of atmospheric absorption. Evidently an accurate knowledge of the diathermancy of the terrestrial atmosphere

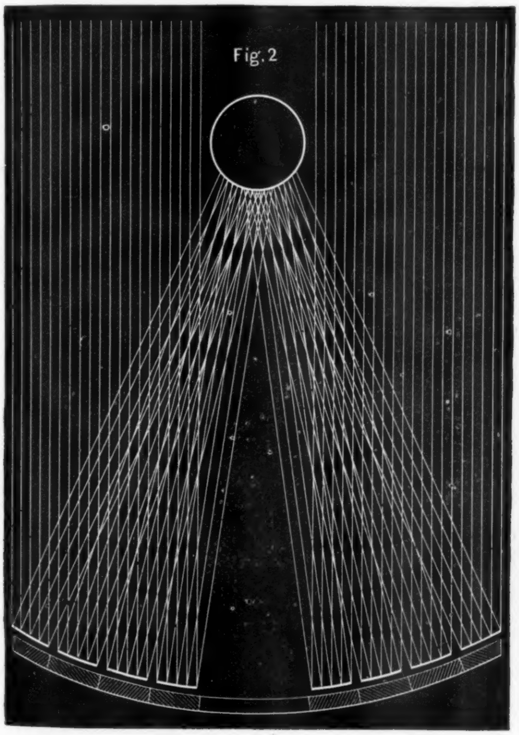


Fig. 2

is indispensable to determine whether the variation of the radiant energy is so great that the development of constant power becomes impracticable. Of course, manufacture and commerce demand a motor developing *full power* during a modern working day of *eight* hours. Observations relating to atmospheric diathermancy continued during a series of years, enable me to assert that the augmentation of solar intensity during the middle of the day is so moderate that by adopting the simple expedient of wasting a certain amount of the superabundant heat generated while the sun is near the meridian (as the steam engineer relieves the excess of pressure by opening the safety-valve) a uniform working power will be developed during the stipulated eight hours. The opening of the safety-valve, however, means waste of coal raised from a great depth at great cost, and possibly transported a long distance, while the radiant heat wasted automatically by the sun motor is produced by fuel obtained from an inexhaustible storehouse free of cost and transportation.

It will be proper to mention that the successful trial of the sun motor described and illustrated in NATURE, vol. xxxi. p. 217, attracted the special attention of landowners on the Pacific coast then in search of power for actuating the machinery needed for irrigating their sun-burnt lands. But the mechanical detail connected with the concentration at a single point of the power developed by a series of reflectors was not perfected at the time; nor was the investigation relating to atmospheric diathermancy sufficiently advanced to determine with precision the retardation of the radiant heat caused by increased zenith distance. Consequently no contracts for building sun motors could then be entered into, a circumstance which greatly discouraged the enterprising Californian agriculturists prepared to carry out forthwith an extensive system of irrigation. In the meantime a simple method of concentrating the power of many reflectors at a given point has been perfected, while the retardation of solar energy caused by increased zenith distance has been accurately determined, and found to be so inconsiderable that it does not interfere with the development of constant solar power during the eight hours called for.

The new motor being thus perfected, and first-class manufacturing establishments ready to manufacture such machines, owners of the sun-burnt lands on the Pacific coast may now with propriety reconsider their grand scheme of irrigation by means of sun power.

JOHN ERICSSON.

THE WHITE RACE OF PALESTINE.

ON the occasion of my first visit to Palestine I was struck by the number of blue-eyed, fair-haired children whom I met with in the towns and villages, more especially in the mountainous parts of the country. At the time I supposed them to be the descendants of the Crusaders or of the other natives of Northern Europe who found their way to the Holy Land during the Middle Ages. But a new light has recently been thrown on the matter by the ethnological observations made by Mr. Flinders Petrie in Egypt.

The winter before last Mr. Petrie was commissioned by the British Association to take casts and photographs of the ethnological types represented on the Egyptian monuments, and to note, wherever it was possible, the colour of the skin, eyes, and hair. It was not the first time, however, that notes of the kind had been taken. Some years ago, Osburn, a careful observer, had noticed that in the sculptures of Ramses II. at Abu-Simbel "the Shasu of Kanana" were depicted with blue eyes, and red hair, eyebrows, and beard, and the Amaur with "the eyes blue, the eyebrows and beard red." As "the Shasu of Kanana" lived a little to the south of Hebron, while the Amaur are the Amorites of the Old Testament, it was clear that a population existed in Palestine in the fourteenth century before our era which had all the characteristics of the white race.

Mr. Petrie's observations have abundantly verified this conclusion. He finds that, on the walls of a Theban tomb, the chief of Kadesh on the Orontes is painted with a white skin, and light red-brown hair. Kadesh was the southern capital of the Hittites, after their invasion of Syria, but the Egyptian inscriptions describe it as being "in the land of Amaur"; and that its chief must have been an Amorite is shown by the fact that the Hittites are depicted with yellow or orange skins, their hair being black, and their eyes dark.

The physiognomy of the Hittites and Amorites, moreover, differed widely. The Egyptian artists agree with the native Hittite monuments in representing the former

with ugly protrusive profile, and Mongoloid features, the hair being arranged at the back of the head in a sort of "pig-tail." The Amaur or Amorites, on the other hand, are a handsome people, tall, and dolichocephalic, with large sub-aquiline noses, and a short pointed beard at the end of the chin. The defenders of "the fort of Amaur" are represented as having been burnt a light pink-red by the action of the sun. Otherwise the skin is white or "sallow."

We learn, then, from the ancient monuments of Egypt that a portion of Palestine was occupied by a white race before its conquest by the Israelites. And they further inform us that this white race continued to exist in the country after the conquest. The physical characteristics of the captives taken by Shishak in the time of Rehoboam from the cities of Judah have Amorite and not Jewish features. There is nothing in common between them and the tribute-bearers of Jehu, who are depicted on the black obelisk from Nimroud, now in the British Museum, with faces of a most typically Jewish cast. In the tenth century before our era, consequently, the bulk of the population in the southern part of Judæa must have been of Amorite origin.

It is not wonderful, therefore, if we find traces of the same population still surviving in Palestine. There is no need of explaining their existence by a theory of their descent from the Crusaders. The survival of the ancient white race of Palestine is parallel to the survival of the ancient white race of Northern Africa, now generally known among French writers under the name of Kabyles. The Kabyles were at one time imagined to be the descendants of the Vandals, but we now know that they have inhabited the southern coast of the Mediterranean since the later Neolithic age. They are the Libyans of antiquity, represented on the Egyptian monuments, like the Amorites, with white skins, blue eyes, and dolichocephalic skulls, and similarly described by classical writers. They extended into Teneriffe and the Canary Islands, and their long-headed skulls have been disinterred from the dolmens of Northern Africa.

To the traveller who sees them for the first time the Kabyles offer a striking appearance. Their clear white skins, covered with freckles, their blue eyes and light hair, remind him of the so-called "Red Kelts" he has met with in an Irish village. They bear a high reputation for physical courage and love of independence, though at the same time they seem to be an orderly people. But they have two characteristics which they share with the white race of Northern Europe. They are mountaineers, the climate of the African plains being apparently too hot for them, and they are distinguished by their tall stature.

These were equally the characteristics of the Amorites of ancient Palestine. The Jews declared that their "height was like the height of the cedar," the Semitic tribes by the side of them seeming to be but "grass-hoppers," and the iron couch of Og, the Amorite king of Bashan, preserved at Rabbath, afterwards the capital of Ammon, excited the wonder of later generations on account of its size.

The Amorites also occupied the whole of the mountainous district of Syria and Palestine from the neighbourhood of Kadesh in the north to the desert southward of Judah, and on the eastern side of the Jordan they founded the two kingdoms of Bashan and Heshbon. In the mountains of Moab and Seir they formed the aboriginal population, partially dispossessed by the Semitic tribes of Moab, Ammon, and Edom, and the name of Horite under which they went in Edom is best explained as meaning "white," in contradistinction to the Semitic Edomite or "red-man." A passage in the Pentateuch (Numbers xiii. 29) expressly states that along with the Hittites and Jebusites they inhabited the mountainous region, while the Canaanites dwelt on the coast and the valley of the Jordan. That Jebusite simply means a cross between Hittite and Amorite is clear from the statement of Ezekiel (xvi. 3, 4, 5) that Jerusalem, whose old name of Jebus gave rise to that of Jebusite, was born of a Hittite mother and an Amorite father. The Egyptian monuments bear witness to the same "interlocking" of Hittite and Amorite.

There is yet a third characteristic which has been ascribed to the white race of Northern Europe. It has been brought into close connection with the dolmens which cover so large a part of its territory. Faidherbe and others have traced a continuous line of dolmens of similar construction along the northern coast of Africa, through Spain, Portugal, and France, into the British Isles. No one, indeed, who has examined the famous dolmens of Roknia, in Algeria, can fail to be struck by their resemblance to the sepulchral cromlechs of our own country. If they are really due to the genius and influence of a single race, it would seem that the race moved from north to south, since the objects found in the dolmens of the south of France betray a more advanced stage of culture than those found in the north.

The chief objection hitherto raised against ascribing these dolmens to the white race with whom they are associated has been that similar megalithic monuments exist in Palestine. Over 700 have been discovered in Moab on the eastern side of the Jordan. Major Conder has drawn attention to others in the basaltic region in the neighbourhood of the ancient Dan, and though none have as yet been observed in Judah, this is probably due to the fact that the attention of travellers has not been called to them. I have myself come across a fine specimen on a hill to the south of Jenîn which had been overlooked by the Palestine Survey, and that megalithic structures once existed in Judah is evident from the occurrence in the Old Testament of names like Gilgal or "Stone-circle," and Ai or "cairn" (Joshua viii. 29). It will be noticed that they are especially plentiful on the eastern side of the Jordan, where the two chief Amorite kingdoms once flourished. Just as the dolmens of Northern Africa were the burial-places of the ancestors of the Kabyles, so tradition affirmed that the Amorite king of Ai had been buried beneath a cairn of stones.

The discovery that the Amorites of Palestine were racially allied to the ancient Libyans opens up ethnological and archæological questions of considerable interest. These cannot be touched upon here, but must be reserved for a future occasion. It is sufficient for the present to have drawn attention to a new and curious ethnological fact.

A. H. SAYCE.

ENGINEERING SCHOOLS.

AT a time when so much is being said about the need for technical education, especially in engineering, the following letter will be read with interest:—

Engineering School, Trinity College, Dublin, June 1888.

DEAR LORD ASHBOURNE,—As you have requested me to draw up a statement of the claims of engineering schools to be recognized by the Civil Service Commissioners as affording part at least of the technical training required of candidates for engineering Civil Service appointments, I send you the following account.

Allow me, in the first place, to state that I am not advocating the claims of our Engineering School here as in any way distinct from that of many other excellent engineering schools that exist. For instance, the Indian Government is so fully convinced of the absolute necessity for a proper technical school training for engineers that it requires all candidates for Indian engineering appoint-

ments to go through Cooper's Hill Engineering School; and yet the Home Civil Service do not in any way even recognize the very same technical training given to other students who stay at home as of any value at all.

The instruction given in engineering schools is of two kinds:—

I. Lectures and demonstrations in mathematics, mechanics, physics, chemistry, geology, &c.; and in the theory and practice of engineering, surveying, &c., &c.

II. Practical training—

(*a*) Practical work in laboratories and workshops in mechanics, machines, physics, chemistry, and field-work in geology.

(*b*) Drawing and office work, including designing, making out specifications, taking out quantities, &c., &c.

(*c*) Practical surveying, and all manner of field work.

(*d*) Inspection of works in progress.

It will be observed what a large and important part of the training given in a school cannot be obtained in an office at all. All the instruction in mathematics, mechanics, physics, chemistry, geology, &c., and in the theory of engineering, and all the important practical laboratory training in these subjects, can only be obtained in a school; and unless an engineer has been properly and *practically* taught these things before entering on his profession, it is almost certain that he will never learn them. In the other more especially engineering parts of the course there are several great advantages in the school course over the office course. In the school, in the first place, the student is under the constant instruction of teachers whose time is devoted to instructing the student, and explaining to him the principles upon which his work depends; and, in the second place, the course of instruction covers as wide a range of subjects as is consistent with teaching each properly. In the office, in the first place, the apprentice has to pick up what instruction he can, and is generally content with a rule-of-thumb knowledge, that may desert him at any really critical juncture; and, in the second place, in any one office the work is yearly becoming more specialized, so that an apprentice will have experience of only a small range of subjects, and, not being acquainted with the theory of even these, will be incompetent to engage in other work.

There are, of course, certain things, such as facility in numerical calculation, and perhaps in the use of field-instruments, acquaintance with the details of specifications in a particular class of work, familiarity with prices at a particular time, and an opportunity of seeing designs carried into execution, which cannot be as well obtained in school as on works. The object of a school being to teach, and of works being to pay, neither can completely supply the place of the other. As a course of technical training for a young engineer, the school course is out of all proportion the more important. What can be learnt from the office course will certainly be acquired, while what can be learnt from the school course will hardly ever be acquired, unless learnt before beginning the practice of his profession. In this age of technical education it is practically certain that in a few years no engineer will be recognized as such unless he has had a proper technical school education, just as in the medical profession it has long ago been recognized that, without a proper medical school education, it is impossible for a doctor to learn the many sciences upon which the successful practice of his profession necessarily depends.

Eminent engineers who have had experience of students taught in engineering schools hold opinions similar to those here enunciated. Our late Professor of Engineering, Mr. Crawford, whose engineering experience is world-wide, is of this opinion. Mr. Bindon B. Stoney, Engineer to the Dublin Port and Docks Board, is of the same opinion. Both these have had experience of school-trained students, and think that the proper course for a young engineer to pursue is to go through a course of instruction in a properly-equipped school, and then to go for a year on works. They consider that a year on works is required to complete the education of an engineer, and they think that a short time on works is quite sufficient for a student who has already gone through an engineering school. Mr. Stoney, for instance, takes students who have been through an engineering school as apprentices for one year, although he will not take untrained apprentices for so short a term.

Foreign Governments in general require all who profess to practise as engineers to go through a proper technical school training, and it is a serious difficulty in the way of English engineers who endeavour to obtain employment on the Continent that, even though they may have been trained in an excellent school, yet this is not recognized by foreign Governments, because our engineering schools are in no way recognized by our own Government.

The Civil Service Commissioners should endeavour to encourage the proper scientific training of the engineers they receive into the public service, and they can do so by recognizing the years spent in an engineering school as equivalent to the same number of years of the technical training that is now required. In the more important appointments, which at present require five years' technical training, the candidate would have to supplement his school course by an office course of at least two years; and this, in the opinion of eminent engineers, as quoted above, would be amply sufficient. In the case of the less important appointments, the school training is probably much better than what satisfies the Commissioners at present; but if it is thought that the special qualifications of an office-trained apprentice are essential, they can be easily secured by requiring in every case at least one year's office experience.

The Civil Service Commissioners should, before recognizing any engineering school as giving the instruction qualifying a candidate to compete for an appointment, inspect the school, and see that it is properly equipped, and has the means and teachers required to teach what it professes. For instance, in some schools there is no special instruction in architecture, and this special teaching should be required of any school that was recognized as qualifying candidates for specially architectural appointments. Similarly, in the case of mechanical engineering, some schools have not the means of teaching it properly, and these schools should not be recognized as qualifying candidates for specially mechanical engineering appointments. A school that teaches civil engineering should be recognized as such, and only as such; and similarly, one that only teaches mechanical engineering should be recognized only as such. In the case of medical appointments, the State recognition of schools is already fully carried out, so that there can be no insuperable difficulty in doing the same in the case of the engineering appointments.

If the Civil Service Commissioners require further information as to the instruction imparted in engineering schools, it would be well for them to inspect University College, London, the City and Guilds of London Institute, and Cooper's Hill, all of which are easy of access from London; and if they require further information they had better appoint some competent Committee to inspect and report to them generally as to the training given in engineering schools, and as to whether they give a technical training that the Civil Service Commissioners would recognize as equivalent to some years spent in an office; and, if not, how the schools should modify their courses so as to give this instruction. Statements as to the nature and value of instruction made by those interested in it and responsible for it are not so valuable as independent testimony.

In conclusion, I would earnestly press upon the Civil Service Commissioners the very great desirability of their encouraging scientifically-trained candidates to apply for

appointments in the Civil Service. The application of scientific principles to engineering is the special feature of our age, and instruction in these principles, and practical training in their application, should be part of the training of every engineer; and this can only be acquired in a properly-equipped school. A want of familiarity with details will surely be remedied, but a want of scientific knowledge will be a lasting cause of danger to the public.

Yours very truly,

GEORGE FRANCIS FITZGERALD.

THE GAPE WORM OF FOWLS (SYNGAMUS TRACHEALIS).

IN the Bulletin of the Buffalo Society of Natural Sciences, vol. v. No. 2, 1886-7, is a paper by Dr. H. D. Walker, which does not appear to have been noticed in this country, on "The Gape Worm of Fowls (*Syngamus trachealis*)." The writer claims to have discovered that the common earthworm (*Lumbricus terrestris*) is the intermediate host of this well-known parasite, and to have observed it in all stages of its development. He further suggests the use of common salt on infected poultry runs to secure the extermination of these noxious pests by destroying the worms which harbour and distribute them.

The series of experiments by which he has arrived at his conclusions are interesting, and afford strong presumptive evidence of their correctness. The earthworms were carefully dissected and examined, the embryonic form of *Syngamus* being found in them, "differing but slightly in structure, so far as can be discovered from the embryo which has passed through one moult after the egg has hatched in water."

The question may be asked: Why should it differ at all if it is the same? It may be suggested that earthworms are themselves subject to various intestinal parasites and that the embryonic forms of many species and even genera are scarcely distinguishable from each other; but with a view to obtaining corroborative evidence Dr. Walker fed some chickens with worms obtained from a place where *Syngamus* had not been noticed. These chickens did not develop the gapes. An examination of worms from this spot showed them to be free from embryos such as were found in others. The double observation certainly points to the probability that in the first instance the embryo of *Syngamus* had been rightly recognized.

Embryos were also found in the œsophagus and in the lungs of birds to which earthworms taken from an infected locality, but carefully washed and cleansed externally, had been given.

The only link apparently wanting to complete the chain of evidence is to determine the manner in which the parasite (if it be truly the embryo of *Syngamus*) makes its way into the intestinal canal of the earthworm.

Dr. Walker concludes that it is taken in with its food. His evidence upon this point is chiefly negative. Eggs of *Syngamus* were placed on damp earth in a dish to which living earthworms were added a fortnight later. After ten days chickens were fed with these worms, but were not attacked. This experiment would have been more complete and perhaps conclusive if the worms had been supplied at the same time with vegetable food. Unless the worms were fed, the only means of entry for the embryos of the parasite must have been by boring through the outer integument of their bodies, which is not suggested.

Dr. Walker notices and examines somewhat critically a paper by Dr. Pierre Mégnin, published under the auspices of the Entomological Society of London in 1883, in which the author, after a minute inquiry into the history, habits, and development of *Syngamus trachealis*, came to the conclusion that the epidemic of gapes is spread, first by "food or drink which has become infested with eggs or embryos; secondly, (by) the diseased birds themselves, which are constantly disseminating the eggs of the parasite; and therefore all other living agents, perfect insects, larvæ, or mollusks (for example, the larvæ of ants, which are the habitual food of young pheasants, have been suspected, with some appearance of reason) may be acquitted of any share in spreading the disease." The American author disputes these conclusions. Admitting that the eggs will hatch in water, and that the embryos may be taken in by birds drinking infected water, he finds no instance, after repeated experiments, in which eggs swallowed by a bird have produced the disease, and although he thinks that exceptional cases might occur, he concludes that the instrumentality of the intermediate host is not ordinarily dispensed with. This is the only material point in which Walker differs from Mégnin, and there is nothing in Walker's discoveries to impair the accuracy of Mégnin's observations, so far as they go. Dr. Walker's observations on the structure and development of the parasite from the egg through its embryonic stages agree substantially in all other respects with those of Dr. Mégnin, except that he believes "the egg of *Syngamus* within the perfect worm just arrived at maturity does not contain a developed embryo," whereas Mégnin found "embryos quite perfect and living in eggs not yet freed from the decomposing bodies of female *Syngami* attached to the tracheal mucous of pheasants that had died of gapes."

The discovery of the distribution of these parasites through the instrumentality of earthworms, which are undoubtedly a favourite food of all young game birds, as well as of domestic fowls, is especially interesting to game preservers, and the theory is strongly supported by their experience.

First, if, as Dr. Mégnin believed, the eggs could be hatched only in water, a gamekeeper could have counted upon reducing to a minimum the risk to his artificially-reared birds by depriving them of water and feeding them upon food carefully moistened with pure spring water only, or more conveniently, upon water that had been first boiled. Many have followed this rule habitually and with good results, but certainly without securing any immunity from occasional outbreaks of the "gapes disease." Secondly, all who have had any experience in rearing pheasants or partridges, or have observed the growth and health of broods of the young of these birds in a wild state, must have noticed that very dry summers are much more favourable to the maturing of full broods and coveys than those in which a greater degree of moisture prevails, but if after very dry weather copious showers or very heavy dews moisten the surface of the ground when the birds have not yet attained their full growth, an outbreak of gapes is almost certain to follow, and is very rapid in its effects. So long as the ground is hard and dry earthworms do not come to the surface, but whenever it becomes sufficiently moistened to permit them to throw up their casts and to reach the surface, all species of birds of which they form a natural or favourite food are eager to seek and to devour them. The birds named by Dr. Walker as those in which *Syngamus* has been found are, with the single exception of the swift, all worm-eating birds. He does not mention on what authority the swift is included in the list, but it is difficult to understand, if water is to be regarded as the only medium of conveyance for this parasitic disease, why many other birds should not also have been found to be affected by it. We believe Dr. Walker's discovery has been received in America with some incredulity, but apart from the careful observations and experiments on which he relies, the accuracy of which there seems to be

no good reason to dispute, the field experience of those who have had the best opportunities of forming an opinion on the subject would tend to support the probability that his conclusions are in the main correct.

WALSINGHAM.

NOTES.

MEN of science will be glad to learn that, at a meeting recently held at Dr. George Johnson's house, it was proposed to make Sir William Bowman some acknowledgment of the appreciation in which he is held on account of his high character, and professional and scientific attainments. A portrait of himself was suggested, and also, possibly, a reprint of some of his publications. Dr. George Johnson, Mr. J. W. Hulke, and Prof. Burdon Sanderson undertook to see Sir William Bowman, and ask his acceptance of the proposal. This consent having been received, a Provisional Committee was at once constituted, at whose invitation a number of eminent men of science formed themselves into the first list of the "Committee of the Bowman Testimonial Fund." As this body is already large and widely scattered, the practical carrying out of the scheme has been relegated to a Sub-Committee, consisting of the Treasurer (Dr. George Johnson), the Secretaries (Dr. W. A. Brailey and Dr. W. H. Jessop), Mr. Power, and Prof. Klein. It is not proposed to place any limit in either direction to the amounts of individual subscriptions, though the Committee are generally of opinion that large subscriptions will be found unnecessary, and that the compliment is a greater one when paid by a longer list of comparatively small subscriptions. They also hope that the funds will allow the distribution of a good reproduction of the portrait to subscribers of at least two guineas. Mr. Frank Holl, whose sudden death is deeply deplored by all who interest themselves in English art, had undertaken to paint the portrait.

IN the House of Commons on Tuesday Sir H. Roscoe asked the Chancellor of the Exchequer whether the astronomical instruments for the international photographic survey of the heavens, recommended by the Royal Societies of London and Edinburgh and the Board of Visitors of the Greenwich Observatory, the estimates for which had been forwarded from the Admiralty some months since to the Treasury, were yet ordered; and, if not, whether, in view of the fact that all the thirteen other sets of instruments were ordered by foreign and colonial Governments last year, and consequently the British Observatories would be placed at a serious disadvantage, Her Majesty's Government would be prepared to put the necessary amount on the Estimates in order to avoid further delay. To these questions the Chancellor of the Exchequer returned the following answer:—"The astronomical instruments required for the international photographic survey of the heavens have not yet been ordered, and the House will soon be asked to vote the necessary funds. It is, I believe, the case that thirteen instruments have been already ordered by different Powers and public bodies, but the hon. member is mistaken in supposing that all the Powers whose co-operation is contemplated have as yet ordered their instruments. On the contrary, two of the Great Powers, so far from ordering their instruments, have not yet definitely declared their intention to take part in the work. I do not think there is any cause to fear that Great Britain will be behindhand in the matter."

AMONG the Civil List pensions granted during the year ended June 20, 1888, were the following:—To the Rev. F. O. Morris, in recognition of his merits as a naturalist, £100; to Mr. William Kitchen Parker, F.R.S., in recognition of his services to science as an investigator, £100; to Mrs. Balfour Stewart, in recognition of the services rendered to science by her late husband, £50.

THE summer meeting of the Institution of Mechanical Engineers was opened at Dublin on Tuesday. In his Presidential address, Mr. Carbutt did not confine his remarks to purely mechanical subjects, but drew the attention of the members to some statistics relating to the population of Ireland and to Irish agriculture and industries. Mr. Carbutt expressed a decided opinion to the effect that more money should be spent in Ireland on education, and especially on technical education. "What I mean by technical training," he said, "is teaching children to use their hands and eyes, and also giving them such practical acquaintance with the applied sciences as may bear upon the industrial employments in their district. I hope the valuable speech on the need of technical education, made by the Marquess of Hartington at our annual dinner in May, will be widely read. I may refer to the work done in the agricultural school at Glasnevin, three miles out of Dublin, of which Mr. Carrol is the head. To this school is attached a farm of 180 acres for teaching practical farming. The Munster dairy school, started in 1880 with a farm of 126 acres, is quite full, and frequently has to refuse pupils. The Government grant to these two schools is £2671. The Baltimore industrial school, the Public Works Commissioners state, will practically be a technical school of fishing. The Belfast technical school is very successful in training pupils in flax cultivation and spinning. Dairy schools have been established twenty years in Denmark, Sweden, Germany, and Normandy. Let me give an example of what the result has been in Denmark. A Report on agricultural dairy schools has been lately presented to Parliament from a Departmental Commission presided over by Sir R. H. Paget, M.P., which states that in 1860 the British Vice-Consul at Copenhagen reported that the butter made in that country was execrably bad. What has happened? Denmark has now ten State-aided dairy schools, with the result that her exports of butter to the United Kingdom have increased as follows:—

1867	80,000 cwts.,	value	£422,479
1877	210,322 ,,	,,	1,347,791
1887	487,603 ,,	,,	2,669,123

In France theoretical and practical lessons in agriculture are now given every week in the primary schools; and a circular has been issued inviting the municipalities to provide for every district a demonstration plot of not less than half an acre for the purpose of applying the principles taught in the school."

Two rather striking speeches on education were delivered at the Sorbonne on Monday at the distribution of prizes to the successful students of the great secondary schools of Paris. M. Blanchet, Professor of History at the Lycée Charlemagne, while expressing a high opinion of the value of the ancient classics in education, urged that methods of instruction should be adapted to the actual wants of the present day. He quoted the following passage written by Fleury at the end of the seventeenth century: "It seems to me that we ought to accommodate our studies to the present state of our manners, and to study those things which are of use in the world, as we cannot change this use so as to accommodate it to the order of our studies." "Truly," said M. Blanchet, "these old pedagogues were great revolutionists. What is new in the history of French pedagogism is not the spirit of innovation and progress but that of routine." M. Lockroy, the Minister of Public Instruction, spoke in a similar tone. It was essential, M. Lockroy pointed out, that Frenchmen should know what was said and written beyond their frontiers. Science was progressing everywhere, and they should be able to follow its progress abroad, especially in Germany and England. That was one reason why the modern languages had such a strong claim on the young of this generation. M. Lockroy protested against the notion that anyone thought of destroying Greek and Latin studies. But these studies were not the only solution of the very complicated problem of modern educa-

tion. Accordingly, he had thought it right to take an opportunity of stating that the problem was receiving close attention. The University was anxious to study it, and would bring to the work its high sentiment of duty, and its passion for the public good.

ON Monday Mr. Howorth asked the Under-Secretary of State for Foreign Affairs whether, in view of the continuous and deplorable destruction of the ancient monuments of Egypt by travellers and others, and of their incomparable value and interest, it would be possible to appoint some Engineer officer to make a survey of those monuments and to have custody of them in future. Sir J. Fergusson replied that it rested with the Egyptian Government to take the necessary measures. A Special Committee had been appointed to consider what ought to be done in the matter, and it had been decided to levy a small fee for seeing the antiquities. This would to some extent increase the sum which it was possible to devote to the preservation of ancient monuments.

THERE is no difference of opinion as to the great variety of uses to which aluminium might be applied if it could be produced in sufficient quantities at a reasonable cost. Hitherto it has been produced, almost entirely in France, by the Deville process; and this process involves so considerable an expenditure that the results have been by no means satisfactory. About seven years ago, Mr. H. Y. Castner, of New York, began experiments in that city with a view to improve the Deville process and cheapen the cost of aluminium by reducing the cost of producing the sodium from which it is obtained. Two years since, Mr. Castner erected experimental works at Lambeth, where he succeeded, after nearly eighteen months of further experimentation, in satisfying a number of men of science and others that he could produce sodium at one-fifth and aluminium at one-third of the cost previously incurred. A company was thereupon formed in order to take up and work the Castner patents. In October last the foundation-stone was laid of new works at Oldbury, near Birmingham, for the production of both sodium and aluminium on a large commercial scale; the works were virtually completed, and the successful manufacture of these products was begun about a fortnight ago; and a large number of gentlemen were invited to visit the works on Saturday last, and witness the processes in actual operation. Among those who accepted the invitation to be present were the Right Hon. A. J. Balfour, M.P., a trustee for the debenture-holders; Sir Frederick Abel, C.B., F.R.S.; Sir Henry Roscoe, M.P., F.R.S.; Lieut.-General Sir Andrew Clarke, G.C.M.G., C.B.; Prof. C. Roberts-Austen, F.R.S., of the Mint; Prof. Dewar, F.R.S.; Dr. Crookes, F.R.S.; Dr. Hugo Müller, F.R.S.; Lord Rayleigh, F.R.S.; Prof. Huntingdon, and others. According to the *Times*, only one opinion was expressed by the gentlemen who visited the works—some of them among the highest authorities on the subject—as to the practical success of all the operations witnessed, and the admirable arrangement of the plant employed. Mr. Castner was freely complimented on the skill and success with which he had developed his system.

DR. HANS REUSCH, of the Norwegian Meteorological Institute, who is engaged in collecting particulars of the earthquakes which occur in Norway yearly, has issued his report for 1887, from which it appears that earthquakes are far more frequent in Norway than has hitherto been imagined. Reports were received of twenty-three, all of which were faint, except three. One occurred on the night of May 7 in the Bömmel Islands, on the west coast, and was accompanied by subterranean detonations, another in the Islands of Værö and Röst, at the extreme point of the Lofodden Group, where doors and windows clattered and the slates on the roofs were pitched off. Again, on November 5, a severe shock of earthquake was felt at Bodö, on the north-west coast. Of the minor shocks those which frequently occurred on the Ytterö are particularly remarkable, as this island lies far out in the ocean, off the coast of Söndfjord.

THE International Meteorological Committee will hold its fourth meeting at Zürich on September 3. This will be the final meeting of the Committee as so constituted. For various reasons it has been found impracticable to organize an International Meteorological Congress, more than one Government having declined to take part in such an assemblage. It is probable that, in future, occasional meetings will be held of a body to be composed of the chiefs of the various existing meteorological services, to whose meetings nothing of a diplomatic character will attach. The arrangements connected with such Conferences have yet to be made.

IN the *American Meteorological Journal* for June, Mr. A. L. Rotch describes the meteorological organization of Austria and the independent observatories in connection with the Central Institute (not including those of the Hungarian service). There is a regular telegraphic weather service, but no storm warnings are issued; an agricultural service, however, exists in the summer season. The pressure at the high mountain stations is reduced to the level of 2500 metres. Mr. G. E. Curtis contributes an article on the trans-Mississippi rainfall, with reference to the popular belief that the rainfall is increasing in the Middle and Western States, the increase being attributed to the building of railroads and the extension of cultivation. Whether the amount of rainfall has actually increased or not does not appear to be proved; the author points out, however, that the breaking-up and tillage of the soil have increased its moisture, and with the growth of vegetation there have come an increased humidity of the atmosphere and a more general diffusion of rainfall. As an evidence of this result it is stated that the streams have a much more even flow than formerly. Dr. A. Woeikof offers an explanation of the different views of Mr. A. Hazen and Dr. Hann as to the general "inversion of temperature" in areas of high and low pressure. Mr. Hazen objects that the statement that, during the passage of anticyclones, the temperatures on high mountains are high in winter, is not applicable to Mount Washington, and thus no law at all. Dr. Woeikof supports Dr. Hann's views, and explains that the exception pointed out by Mr. Hazen may be due to the different type of weather in the Eastern States and in Europe, and to the greater rapidity of the passage of anticyclones in the former locality.

ANOTHER contribution to the chemistry of the rare earths, by Drs. Krüss and Kiesewetter, will be found in the current number of the *Berichte*. The somewhat startling results published a year ago by Drs. Krüss and Nilson, involving as they did the announcement of the existence of a large number of new chemical elements, appear to receive additional confirmation by this subsequent work undertaken by the two former chemists. They are not yet in a position to announce the complete isolation of any one of these new elements, but so much progress has been made in this direction that a mixture containing only two of them in any quantity has been arrived at. The task of separating these elementary constituents from the minerals which have hitherto been examined appears, in the face of the fact that their properties are so similar—their known salts being almost equally soluble, and the basicities of their oxides so nearly alike—well-nigh impossible. But the results of the examination of a large number of Scandinavian minerals show that Nature herself, with her infinite resource of time and circumstance, has partially, possibly in some yet unknown instance completely, performed this long and laborious operation for us. Different minerals from the same place, and even the same mineral from different localities, are shown by the absorption-spectra of their nitrates to consist of different constituents in

varying quantities. Hence, by extending the observations over a large number of specimens it is possible to find a few which contain only a small number—one, two, or three—of these new elements in any considerable quantity. Working upon this principle, Drs. Krüss and Kiesewetter have been fortunate in discovering a mineral, yttro-titanite of Arendal, the absorption-spectrum of whose nitrates indicates the presence in large quantity of only two elements, viz. that constituent of didymium termed $D\iota\delta$, and the constituent $X\zeta$ of holmium. The bands of these elements are very intense, and are of wave-lengths 521·5 and 452·6 respectively. Samarium is entirely absent, but there are small quantities of constituents of erbium and thulium present. However, the $D\iota\delta$ and $X\zeta$ so largely preponderate, that their fractionation is being undertaken. This happy discovery goes very far to prove the accuracy of the deductions made by Krüss and Nilson, which have caused so much discussion in chemical circles; for of the elements composing the mixture called didymium we have here only one of them, and of the constituents of holmium we have likewise but one representative. Therefore the compound nature of didymium and holmium may now be taken as proved.

AT the meeting of the Scientific Committee of the Royal Horticultural Society, on the 24th ult., Dr. Masters showed ripe fruits of the Plymouth strawberry, grown from plants presented to him by Mr. G. F. Wilson. This curious monstrosity is an alpine strawberry, in which all the parts of the flower are more or less represented by leaves. The plant was mentioned by old botanical writers, but afterwards disappeared, or was so completely overlooked that its very existence was assumed to be a myth. Of late years, however, the plant has reappeared in several gardens, and the correctness of the old writers has been vindicated.

PLASTER-OF-PARIS models of the bed of the Atlantic Ocean and of that of the Carribean Sea have been sent by the United States Hydrographic Office to the Cincinnatti Exhibition. They were made by Mr. E. E. Court, of the Hydrographic Office; and the charts from which they were constructed were carefully revised by Commander J. R. Bartlett and Lieut. J. L. Dyer, respectively former and present Hydrographer. *Science* suggests that duplicates or even photographs of these models would be of very great value in the teaching of physical geography. That of the bottom of the Atlantic would, says our American contemporary, give a pupil more actual instruct ion in a quarter of an hour than could be obtained by a week's study of descriptive text. This model, it seems, shows many things that will be surprising to almost everybody except the expert hydrographer. One of these is the great height of many of the small islands from the ocean's bed, when compared with their area either above the surface of the water or where they rest upon the bottom of the sea. This height is exaggerated in the model by the perpendicular scale being made fifty times as great as the horizontal scale; but, even allowing for that, these islands stand up like tall, narrow, truncated cones, many of them not being more than twice as far across at the base as at the top.

THE United States Fish Commission lately sent off to California 600 live lobsters, 350 of which arrived safely at Sacramento. Several attempts had previously been made to send live lobsters across the North American Continent, but had failed. In the present instance, as we learn from *Science*, Colonel McDonald, Fish Commissioner, personally superintended the packing of the lobsters. A crate or box devised by the late Captain Chester was used. This was placed within another larger box, the intervening space being filled with pounded ice. In the inner box the lobsters were placed between layers of rock-weed, which at times was moistened with sea-water. Each box had an independent drain, so that the fresh water from the melting ice could not enter the lobster-box. The temperature of the latter was kept at 45° F. A Fish Commission car was used, the boxes along the side of it serving as the outer box of the combination described above; one hundred crates, each containing six lobsters, being placed in them, and surrounded with ice. Each morning before sunrise a careful inspection of the lobsters was made, and those that had died were removed. The first day 45 died; the second day, 55. After that the mortality was much less. All of those that died were in an advanced state of shedding, and were in poor condition when they started. One half of the 350 lobsters that arrived safely on the Pacific coast were placed in the ocean north of San Francisco, and the other half south. The condition of the water in that region is similar to that of the Atlantic off the Massachusetts coast. The temperature is about the same, but is more constant. The lobster on the Massachusetts coast crawls out into deep water in the summer, where the temperature is low, but it is thought that the equable temperature of the Pacific will enable the lobster in those waters to spend the whole year in one spot.

AN account of two interesting old globes in the library of the Middle Temple will be presented in the next volume of the Hakluyt Society's series. These globes, one terrestrial, the other celestial, were made by E. Molyneux in 1593, and were the first ever produced in England. The geography on the terrestrial globe was afterwards brought down to 1603. A description of the globes was written in Latin in 1593 by Robert Hughes, a mathematician of the period. This description was rendered into English by Chilmead, of Oxford, in 1623; and Chilmead's translation, which has been prepared for publication by Mr. Coote, of the Map Department of the British Museum, will form the substance of the forthcoming volume. The editor of the volume is Mr. Clements Markham.

THE Report of the Council of the North-Eastern Sanitary Inspection Association for 1887–88—the fifth financial year of the Association—has been issued at Newcastle. Excellent work is evidently being done by the Association. One of its good deeds has been the formation at Newcastle of a permanent exhibition of sanitary appliances. This exhibition was fitted up at considerable outlay by the Association as well as by exhibitors, and is open daily, free to the public, to whom it has proved of great value. "To see the best appliances in each department properly fitted," says the Report, "and to have any explanation desired freely given, where there is nothing on sale, are advantages that must be the better appreciated the more widely they are known. So far as known, there is no better permanent collection in the Kingdom."

IN the *Entomologist's Monthly Magazine* for August, Dr. R. C. R. Jordan presents a list of species of Lepidoptera taken by him during a short visit to Jersey. In this list there are several species which have not hitherto been known to occur in the Channel Islands. Dr. Jordan proposes that a Committee of working entomologists should be formed for the thorough investigation of all orders of insects inhabiting these islands.

WE have received the second supplement of Mr. John Wheldon's Botanical Catalogue. It includes, besides a large number of books relating to botanical subjects, many important works on agriculture.

THE Calendar of the Heriot-Watt College, Edinburgh, for the session 1888–89, has been issued; and it is satisfactory to find that in this well-known institution provision is made for that higher commercial and technical education about which so much has lately been said. It is claimed that the College possesses, in its lecture theatres, laboratories, and workshops, every facility for preparing young men for work as merchants, manufacturers, or engineers, and for supplying in the evening such instruction as is required by those already employed in such occupations.

AT a recent meeting of the Wellington Philosophical Society, Mr. J. W. Fortescue spoke of the rapid increase of deer that have been acclimatized in the New Zealand mountains. Having had special facilities for observing these creatures, he proceeded to state some interesting facts as to their habits. At the close of his address Sir James Hector asked Mr. Fortescue, as an expert on the subject, whether the chief use of the antlers was not so much for fighting as for facilitating the progress of the stag through dense woods. He had considerable experience with the wapiti, in North America, and found that by throwing up the head, thereby placing the horns along the back, the animals were enabled to go forward with great rapidity and follow the hinds. He asked this, as it had been stated at a previous meeting of the Society that the antlers tended to entangle the deer. Mr. Fortescue said that Sir James Hector was quite correct in stating that the antlers assisted the stags in penetrating dense forests. Mr. Higginson also bore out this statement from his experience in India.

ON July 23, at 11.17 p.m., a brilliant meteor was seen in the province of Småland, in Sweden. At Nexjö it was seen due east, falling perpendicularly towards the horizon, when it suddenly burst.

DURING the month of June severe frosts occurred in the north of Finland, doing great damage to the crops.

NORWEGIAN hunters returning from the Arctic regions report much ice and severe storms.

ZOOLOGICAL GARDENS are being laid out in Christiania and Helsingfors.

THE additions to the Zoological Society's Gardens during the past week include a Feline Douroucouli (*Nyctipithecus vociferans*) from Savanilla, presented by Master Lester Ralph; a Crested Grebe (*Podiceps cristatus*), British, presented by Mr. W. Nicholls; a Brazilian Cariama (*Cariama cristata*) from South-East Brazil, presented by Mr. Fredrick Rose, jun.; an Indian Kite (*Milvus govinda*) from India, presented by Mrs. D ean; a Green Turtle (*Chelone viridis*) from the West Indies, presented by Baron Henry de Worms; a Hawk's-billed Turtle (*Chelone imbricata*) from the Bahamas, presented by Mr. W. T. Manger; a Corn Snake (*Coluber guttatus*) from North America, presented by Mr. J. Garnett; a Common Viper (*Vipera berus*), British, presented by Mr. F. C. Smith; a Virginian Fox (*Canis virginianus* ♀) from North America, deposited; a Derbian Screamer (*Chauna derbiana*) from the Northern Coast of Columbia, a Prince Albert's Curassow (*Crax alberti* ♀) from Columbia, four Beautiful Grass-Finches (*Poëphila mirabilis*), four Gouldian Grass-Finches (*Poëphila gouldiæ*) from Australia, purchased; two Rose-coloured Pastors (*Pastor roseus*) from India, received in exchange; two Collared Fruit Bats (*Cynonycteris collaris*), two Mule Deer (*Cariacus macrotis* ♂ ♀), a Canadian Beaver (*Castor canadensis*), a Thar (*Capra jemlaica*), born in the Gardens; a Brazilian Cariama (*Cariama cristata*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

VARIABLE STARS.—Mr. Sawyer gives, in Nos. 174 and 176 of *Gould's Astronomical Journal*, the results of his observations of variable stars in the year 1887. The following are the observations for the more regular variables:—

R Virginis	M	June 17	Mag. 7·1	Calculated	June 21
S Coronæ	M	Apr. 19	7·1		Apr. 6
R Lyræ	M	Sept. 9			Aug. 31
	M	Oct. 15			Oct. 16
	m	Nov. 10			Nov. 16
	M	Nov. 29			Dec. 1

The calculated dates are those which have been given in NATURE in the column heade l "Astronomical Phenomena." U Monocerotis was observed at maximum on Jan. 15, March 4, April 28; and at minimum Feb. 18 and April 6; R Scuti was observed at maximum on Oct. 27, and at minimum on Sept. 14 and Nov. 23; W Cygni was at minimum, mag. 6·7, on July 23 and Dec. 8, and at maximum, mag. 6·1, on Sept. 13; Mira Ceti was at maximum, mag. 4·4, on 1886 December 30.

Mr. John Tebbutt reports (*Astr. Nachr.*, No. 2849) that η Argûs has undergone a notable increase of brilliancy of late, as he observed it as 7·0 mag. on May 19 of this year; whilst on April 23, 1887, it was only 7·5.

COMET 1888 *a* (SAWERTHAL).—The following ephemeris for Greenwich midnight for this object is from the *Dun Echt Circular*, No. 157:—

	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log *r*.
Aug. 3	1 3 26	53 51·6 N.	0·3409	0·3881
5	1 2 5	54 5·5		
7	1 0 35	54 18·3	0·3424	0·3973
9	0 58 55	54 30·0		
11	0 57 5	54 40·5	0·3439	0·4062
13	0 55 5	54 49·8		
15	0 52 57	54 57·8	0·3455	0·4149
17	0 50 40	55 4·4		
19	0 48 15	55 9·7	0·3471	0·4234
21	0 45 42	55 13·6		
23	0 43 2	55 16·0 N.	0·3489	0·4316

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 AUGUST 5–11.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 5

Sun rises, 4h. 33m.; souths, 12h. 5m. 41·8s.; sets, 19h. 39m.: right asc. on meridian, 9h. 3·6m.; decl. 16° 48′ N. Sidereal Time at Sunset, 16h. 38m.

Moon (New on August 7, 18h.) rises, 1h. 57m.; souths, 10h. 8m.; sets, 18h. 17m.: right asc. on meridian, 7h. 5·8m.; decl. 21° 12′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	2 55	10 54	18 53	7 51·3	20 47 N.
Venus.....	5 7	12 35	20 3	9 32·6	16 2 N.
Mars......	12 37	17 21	22 5	14 19·9	15 17 S.
Jupiter....	14 16	18 40	23 4	15 38·6	18 44 S.
Saturn....	4 13	11 55	19 37	8 52·7	18 15 N.
Uranus ...	10 16	15 54	21 32	12 52·7	4 58 S.
Neptune..	23 17*	7 4	14 51	4 1·3	18 58 N.

* Indicates that the rising is that of the preceding evening.

Aug.	h.	
6	9	Mercury in conjunction with and 0° 18′ north of the Moon.
7	10	Saturn in conjunction with and 0° 16′ south of the Moon.
7	—	Partial eclipse of Sun: visible as little more than a bare contact at Greenwich, beg nning at 18h. 49m. and ending at 19h. 6m.
8	9	Venus in conjunction with and 0° 42′ south of the Moon.
10	23	Mercury at least distance from the Sun.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m	
U Cephei	0 52·4	81 16 N.	Aug. 9,	19 49	*m*
Algol	3 0·9	40 31 N.	,, 5,	20 2	*m*
U Hydræ	10 32·0	12 48 S.	,, 11,		*M*
δ Libræ	14 55·0	8 4 S.	,, 9,	23 26	*m*
U Coronæ	15 13·6	32 3 N.	,, 9,	1 42	*m*
U Ophiuchi	17 10·9	1 20 N.	,, 9,	1 16	*m*
			,, 9,	21 24	*m*
Z Sagittarii	18 14·8	18 55 S.	,, 8,	0 0	*m*
β Lyræ	18 46·0	33 14 N.	,, 9,	21 0	*M*
η Aquilæ	19 46·8	0 43 N.	,, 6,	22 0	*m*
X Cygni	20 39·0	35 11 N.	,, 8,	1 0	*M*
T Aquarii	20 44·0	5 34 S.	,, 5,		*M*
T Vulpeculæ	20 46·7	27 50 N.	,, 10,	23 0	*M*
δ Cephei	22 25·0	57 51 N.	,, 9,	20 0	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
The *Perseids*	44	56 N.	Max. August 10. Swift; streaks.
Near 41 Arietis	44	25 N.	Swift; streaks.
	96	72 N.	Slow.
Near θ Cygni	293	52 N.	Rather slow.

ON PARTIAL IMPREGNATION.[1]

DURING our researches on the formation of polar-bodies (see NATURE, vol. xxxvi. p. 607) we made the following observations, which are of considerable interest in connection with the theory of sexual reproduction.

As we were able to show that parthenogenetic eggs form only *one* polar-body, while sexual eggs give rise to *two*, we looked out principally for those cases in which both kinds of eggs are present in the same species.

On examining the sexual eggs ("Dauereier") of certain species of *Moina*, we found, to our astonishment, that even those which possessed a firm vitelline membrane, and in which four segmental cells were already present, still contained a sperm-cell.

We first of all took this to be a supernumerary spermatozoon which had penetrated into the egg, but it was soon apparent that all eggs of a corresponding stage contained a similar sperm-cell, and that there was always *one* only. Further observations showed us *that we had had here to do with a case of partial impregnation. Only one of the first four segmental cells, and not the entire egg-cell, becomes united with the sperm-cell.* This is the case, at least, in *Moina paradoxa*. In *Moina rectirostris*, impregnation must occur at a rather later stage, for in this species we have seen eggs in which the first four segmental cells were again ready for division, and still the sperm-cell had not fused with one of them.

In *Moina paradoxa* the process takes place as follows:—Immediately after the extrusion of the egg into the brood-chamber, it is a naked sausage-shaped mass. In this stage, a spermatozoon penetrates into it in the region of the vegetative pole, and then the vitelline membrane becomes formed, and prevents the entrance of a second. The germinal vesicle at the same time becomes transformed into the first polar-spindle, which lies at the surface; the first, and soon afterwards the second polar-body then becomes constricted off, and the nucleus of the ovum, surrounded by protoplasmic particles, migrates to the centre of the egg, which has by this time contracted to the usual form. Now follows the first division of the ovum, which, however, only consists in a separation of these first, or, as we will call them, *secondary* egg-cells in the centre of the egg;—the two first segmental cells come to lie, as usual, in its longitudinal axis—one, which is always recognizable by the proximity of the polar-bodies, nearing the animal pole, the other the vegetative pole. *The sperm-cell always lies in the neighbourhood of the latter*, without, however, yet becoming united with it.

Then follows a second division of the segmental cells, together with the separation of the daughter-cells in the transverse direction. There are now four star-shaped daughter-cells present, which lie at an almost equal distance apart, at a right angle with one another. The sperm-cell can be seen near one of the two lower (*hintern*) cells, and it now begins to show amœboid movements, and to approach the segmental cell, a short narrow bridge of protoplasm being formed, and the two cells beginning to unite with one another. *Fusion then follows, and in the next following stage, of eight segmental cells, no sperm-cell can any longer be seen in the egg.*

The uniting of the sperm-cell with the cell- and nuclear-constituents of the egg thus only takes place *after* the embryonic development has already advanced to the four-celled stage. It would naturally be of great interest to know what eventually becomes of those segments which are concerned in fertilization—that is, which parts of the embryo are formed from them. A very possible supposition is, that only those parts of the egg become fertilized out of which the germ-cells of the young animal will subsequently be formed. This conjecture is rendered by no means improbable by the fact that it is one of the two segmental cells lying at the vegetative pole of the ovum which becomes fertilized; for it is from these cells, according to Grobben's beautiful discovery with regard to the summer eggs of *Moina*, that the germ-cells arise. At a future time we hope to be able to speak more definitely on this point: at present it is only necessary to add that we are studying these processes in other *Daphnidæ*, and have already observed a similar series of stages in *Sida crystallina* to those above described. But in this case fertilization occurs earlier, in the two-celled stage of segmentation.

Freiburg i/B., December 12, 1887.

P.S.—In the continuation of the above observations another case has presented itself, in which impregnation does not take place until eight segmental cells have been formed. This happens in *Daphnia pulex*. Further details concerning partial impregnation, as well as theoretical support of the facts treated of above, we reserve for a future occasion.

May 21, 1888.

[1] Translated from a paper by A. Weismann and C. Ischikawa (*Berichte der Naturforschenden Gesellschaft zu Freiburg i/B.*, Bd. iv., Heft 1, p. 51).—W. N. P.

Addendum to the above Note on Partial Impregnation,[1] by Weismann and Ischikawa.

SINCE giving a short abstract of the observations which led us to the conclusion of the existence of partial impregnation, we have continued our researches, and have come to the conclusion that, in spite of the entire accuracy of our facts, we were mistaken as to the explanation of the phenomena described. The fusion with one of the eight first segmental cells does indeed take place regularly, but the uniting cell is not the sperm-cell. The first segmentation nucleus is here, as in all sexual eggs, formed by the fusion of the nucleus of the ovum with the sperm-nucleus, and the fusion of the two cells observed by us at a later stage *is something additional to the ordinary impregnation.* That this is the case is quite certain: we found the sperm-nucleus and its subsequent fusion with the egg-cell to occur in *the same* ova in which we could prove the presence of that cell which we at first took to be the sperm-cell.

We can hardly be blamed for this error if it be borne in mind that we found this cell, *without exception*, in every egg which had just passed into the brood-chamber; that the vitelline membrane was formed directly afterwards; and that, on the other hand, a fusion of this cell with one of the first eight segmental cells lying at the vegetative pole of the egg could be seen in *all* ova which we possessed of this stage, viz. in five species—two species of *Moina*, two of *Daphnia*, and one of *Polyphemus*. The fact that the form and size of the supposed sperm-cell differ from those of the sperm-cells in the testis of the corresponding species was indeed an objection to our explanation: it has, in fact, almost the same size and shape in all species. But the sperm-cells become altered as soon as they pass into the egg, and it was shown some time ago by Fol and Hertwig, and more recently by Boveri, that the sperm nucleus grows considerably when within the ovum. Moreover, in one of the species examined (*Polyphemus*), as well as in *Bythotrephes*, the sperm-cell is extraordinarily large, and in both these species we followed the entrance of the enormous amœboid sperm-cell into the ovum by means of sections, step by step, and were able to convince ourselves of its essential correspondence with the supposed sperm-cell in the eggs of other species. What else could this cell within the ovum be, if it were not the sperm-cell? It was never wanting, and on the other hand there was *always one only*, so that any idea of its being a parasitic organism was out of the question. Moreover, the two polar cells were always present, so that it could not be mistaken for one of these. And up to the present time no one had ever seen any other cell but the sperm-cell within the ovum.

We should hardly, indeed, have discovered our error so soon, if we had not remembered that one of us had found some years ago that unimpregnated sexual eggs of Daphnidæ soon become disintegrated,[2] and had we not asked ourselves how the embryonic development advanced in such unimpregnated eggs before disintegration begins. For, as we believed that the sperm-cell was only ready for conjugation in impregnated eggs after they had segmented into eight parts, it was to be expected that segmentation would take place up to this stage in unimpregnated ova, and that then only would the disintegration begin. Had we found

[1] Translated from the proof of a paper to appear in the *Berichte der Naturforsch. Gesellschaft zu Freiburg i/B.*, Bd. iv. Heft 2, 1888.—W. N. P.

[2] See Weismann, "Beiträge zur Naturgeschichte der Daphnoiden," iv.; "Ueber den Einfluss der Begattung auf die Erzeugung von Wintereiern," *Zeitsch f. Wiss. Zool.*, Bd. xxviii. p. 198 *et seq.*

it otherwise, and did the first stages of division not occur in unfertilized eggs, we should have supposed that the sperm-cell present in the ovum, although in a resting-stage, had some invisible influence over it.

It was possible, however, to arrive at a decision on this point; for, although most Daphnidæ do not lay their eggs if copulation does not take place at the time the eggs ripen, in one species (*Moina paradoxa*), the extrusion of the ova occurs independently of copulation. We therefore isolated females of this species which contained ripe eggs in the ovary, and examined them when they had passed the eggs into the brood-chamber. How great was our astonishment to find that these ova, killed shortly afterwards, were already beginning to disintegrate, and a cell corresponding to that which we had taken for the sperm-cell was present in *each* of them! At first we considered the possibility of copulation having taken place before the females were isolated, and of the retention of the sperm-cell, which had become inactive, in the brood chamber. But sections which we made through nearly ripe ovarian eggs showed us that the supposed sperm-cell was already present in them. It was thus proved that this cell which unites with one of the eight first segmental cells (we will for the present call it the "conjugating-cell," *Copulationszelle*) cannot be an ordinary sperm-cell; and, moreover, that, besides it, an active sperm-cell from the male, which had previously escaped our notice, passes into the egg in consequence of copulation. In fact, this true spermatic element was found after renewed examination of old and new series of sections as an exceedingly small nucleus in the yolk-mass. It is difficult to recognize, but nevertheless may plainly be traced passing into the yolk, and finally uniting in the ordinary manner with the nucleus of the ovum.

Thus the impregnation of these ova is not exceptional, inasmuch as a normal fusion of the male and female nuclei takes place. But, besides this normal conjugation of sperm-nucleus and egg nucleus, another fusion of cell-bodies and cell-nuclei occurs between the enigmatical "conjugating-cell," present already in ovarian eggs, and one of the eight first segmental cells lying at the vegetative pole of the ovum.

It will be impossible to conjecture as to the meaning of this process until we know definitely how the "conjugating-cell" arises: at present we are not able to state anything about it with certainty.

We intend to continue our observations, and hope before very long to have more to say on this subject.

Freiburg i/B., July 12, 1888.

HOW TO INCREASE THE PRODUCE OF THE SOIL.[1]

IN this pamphlet Prof. Wagner distinctly asserts the power of leguminous cultivated plants, such as peas, beans, vetches, lupines, and clovers, to use the free nitrogen of the air for purposes of nutrition. As this conclusion is distinctly at issue with the opinions of the Rothamsted school, it revives a question of deep interest, the answer to which has varied with our knowledge from time to time. In the earlier days of agricultural chemistry the "mineral theory" of plant nutrition was in the ascendant. According to this theory the mineral, earthy, or ash constituents were taken from the soil, while the gaseous, combustible or organic portions of the plant were derived from the air. As knowledge progressed, this somewhat bold and sweeping generalization required to be modified, and the most usually received view (in this country, at least) for some time past has been that of the absorption of mineral matter and nitrates from the soil, and of carbonaceous matter from the air, and to a limited extent from the soil in the form of carbonic acid gas in solution. It has been urged that proof is entirely wanting of the alleged power of plants to take free or combined nitrogen from the atmosphere, while the intense effect of nitric nitrogen upon growing crops, when added to the soil, has amply proved that the soil is a source of nitrogen, and, according to received views, the chief or only source of nitrogen to growing crops. The results obtained by Sir John Lawes, Dr. Gilbert, and Mr. Warrington at Rothamsted, upon the cultivation of red and Bokhara clover, have been considered as proving that the source of nitrogen in these plants was not the atmosphere, but the soil and the subsoil, the plants having been found to send down their roots some fifty-four inches in depth into sections of the soil which, although out of reach of most cultivated plants, were able to yield sufficient nitrogen for the uses of these nitrogen-loving plants. Collectors of nitrogen these plants are allowed to be by all, but at Rothamsted the collection is considered to be carried on in the deeper layers of the soil, and not to extend above ground. Prof. Paul Wagner declares that cultivated plants may be properly divided into nitrogen *collectors* and nitrogen *consumers*, or as we might put it, into nitrogen savers and nitrogen wasters. In the first class are arranged the various members of the Leguminosæ already named. At a certain stage of their development these plants acquire the power of taking all their nitrogen from the air. They thus become a means of securing fertilizing matter from a free source, and are therefore profitable. In the second class are placed the cereals, grains, turnips, flax, &c., all of which are able to take next to nothing from the store of nitrogen in the air, but which waste the nitrogen of the soil, and must take from it, in the form of nitrates, all the nitrogen they contain. In the pamphlet under notice no proof is adduced for these views, but reference is made to the detailed investigations carried out by the author, Hellriegle, and E. von Wolff. These views must be considered as reactionary and startling, and as diametrically opposed to the current of opinion in this country for some years past.

It is not to be wondered at that Prof. Wagner should give considerable prominence to a feature in agricultural practice which has almost entirely disappeared—green crop manuring. If clovers, lupines, and vetches, extract their nitrogen from the supernatant aërial ocean, and are able to supply upwards of 180 pounds of atmospheric nitrogen per acre per annum continuously for a period of three years, no easier system could be devised for obtaining the necessary nitrogen for fertilizing purposes. All that is required is to secure the full development of the nitrogen collector by supplying it with sufficient water, sufficient phosphoric acid, potash and lime, so that it may exert its powers upon the constantly passing stream of air—it then provides nitrogen for itself. What is this but a re-statement of the old mineral theory applied especially to the Leguminosæ?

Prof. Wagner's views upon the absorption of atmospheric nitrogen and his consequent recommendation of green crop manuring, are the two principal features of this little work. In some places the German fault of verbiage is only too evident—whole paragraphs being devoted to what is perfectly self evident. Still, various practical suggestions of great value are made. The remarks upon the proper method of applying nitrate of soda are particularly worthy of attention. The effect of this active manure in developing stem- and leaf rather than flower and fruit is acknowledged, but only as a consequence of the period of the plant's growth when it is applied.

Nitrate of soda enables the plant to seize upon the stores of phosphoric acid, potash and lime in the soil, and the effect is rapid growth. This effect is however short lived, as the nitrate is freely movable in the soil, and readily finds its way to lower sections when it is no longer available. The case is therefore as follows:—Nitrate of soda applied in February, March, or April, is employed in the development of leaf and stem, and by the time the period has arrived for grain formation it is spent. If the same dressing had been applied later in the history of the crop, and at the time when the embryo grain was being formed, the same stimulus would have been given towards grain formation, which under ordinary circumstances takes the form of leaf and stem development. The practical recommendation based upon the consideration is to apply one-sixth part of the application in autumn, two-sixths in March, and the remaining three-sixths in May. The plant is to be fed during its whole life, and not only at the period when it is forming leaves and stem, but especially at the important period when it is forming fruit. The remarks upon the ripening effects of superphosphate upon root crops are also well worthy of attention. Excessive quantities of superphosphate hasten too rapidly the processes of maturation, and tell against prolongation of growth into the late autumn, and this, it is submitted, accounts for the occasionally smaller results obtained by the use of phosphates in large quantities as compared with those produced by more moderate dressings.

Prof. Wagner comes to the conclusion, which we quite agree in, that nitrogen, phosphoric acid, and potash are the principal elements of fertility that require to be added to soils. The remaining essential substances, although equally important to the well-being of the plant, are usually present in ample quanti-

[1] "The Increase in the Produce of the Soil through the Rational Use of Nitrogenous Manure." By Prof. Paul Wagner, of Darmstadt. Translated by George G. Henderson. (London: Whittaker and Co., 1888.)

ties in cultivated soils. We might be disposed to eliminate the potash as also usually sufficiently prevalent. The fact that straw is almost invariably returned to arable land is in itself a safeguard against the exhaustion of potash; and the considerable percentage found in most soils, especially those of argillaceous character, points to the same conclusion. The farmer has then chiefly to consider the supply of phosphates and of nitrates, and, with regard to these two, Prof. Wagner thinks that the former ought to be in excess of what is required, and that the farmer should equally devote his attention to the proper supply and application of nitrates to the soil. The recommendation that phosphates should be in excess is based on the observation that growth is seldom regular. It depends on climatic conditions, and sometimes is arrested by drought or low temperature for two or three weeks, while in well cultivated and well fertilized ground vegetation makes extraordinary progress in three or four days. The supply of phosphates ought therefore to be in excess of what may be required under ordinary conditions of growth, and should be abundant enough to supply the plant under the most rapid conditions of growth. The conclusion is that phosphates may be applied liberally and without hesitation or limit, *i.e.*, without scientific accuracy. The case of nitrates is different, as they are so easily available and so freely mobile in the soil, that the plant has no difficulty in appropriating them. The nitrates probably find their way into the plant before they are required, and are stored up and elaborated gradually as the plant takes up further supplies of mineral nutriment. The rapidity with which they disappear and their extraordinary effect mark the nitrates out as the chief object of study in manuring land.

JOHN WRIGHTSON.

THE BURIAL CUSTOMS OF THE AINOS.

MR. BACHELOR, to whose investigations on the subject of the Ainos of Yezo we have frequently referred, writes, in a recent issue of the *Japan Weekly Mail*, on the burial customs of this race. He says that as soon as a person dies, a blazing fire is made, the corpse is dressed in its best garments, which are neatly laced up, and is laid lengthways on the right-hand side of the fireplace. The relatives and friends of the deceased sit around the remaining parts of the fireplace, and usually they are so numerous as to fill the hut. In all cases many sacred symbols (*inao*) are made, and placed around the hut and the dead body. Mr. Bachelor has seen the corpse of a woman laid out. She was well dressed, and had her utensils and paraphernalia about her (the rings and beads being, in this instance, laid upon her bosom), and was shod with pieces of white calico which Mrs. Bachelor had, a few days previously, given to the husband of the deceased to bind up his wounded foot. Any white material seems to be especially welcome to the Ainos for wrapping up the bodies of their dead. When the body has been properly dressed, and when the necessary eating-vessels or hunting materials are placed in position, a cake made of millet, or a cup of boiled rice and some wine, are placed by its side, and the spirit of the departed is supposed to eat up the essence of these things. Then the goddess of fire is implored to take charge of the spirit and lead it safely to the Creator of the world and the possessor of heaven, and she receives various messages to the Deity setting forth the praises of the dead and extolling his many virtues. Millet cakes and wine are then handed round to every member of the assembled company, and each of them offers two or three drops of the wine to the spirit of the dead, then drinks a little, and pours what remains before the fire as an offering to the fire-goddess, to whom they have not ceased to pray; then part of the millet cake is eaten, and the remainder buried in the ashes on the hearth, each person burying a little piece. After the burial these scraps are collected and carried out of the hut and placed before the east window, which is regarded as the sacred place. The corpse is then carefully rolled up in a mat, neatly tied up, attached to a pole, and carried to the grave by two men. The mourners follow after the corpse, in single file, each carrying something to be buried in the grave, the men leading and the women following them. The grave is from $2\frac{1}{2}$ to $3\frac{1}{2}$ feet deep, and round the inside of it stakes are driven, and over them and at the bottom of the grave mats are placed. Then the body is laid in the grave, with numerous little knick-knacks—cups, rings, beads, a saucepan and some clothing being buried with the woman, a bow and quiver, an eating and a drinking cup, tobacco, a pipe, a knife with the men, and play-things with the children. These things are always broken before being put into the grave, and it is noticeable that they are not usually the best the deceased had during life. Everything is then closely covered with mats; pieces of wood are placed so as to form a kind of roof, and on this the earth is piled. A pole is generally stuck at the foot of the grave to mark the spot. No prayers are offered up during burial. The mourners then return to the hut, where the men pray, make *inao*, *i.e.* sacred symbols, eat, drink, and get drunk. The dead body is never allowed to remain in the house longer than one day; and, once the funeral is over, the name of the departed is never mentioned.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE following is the list of Scholarships, prizes, and Associateships awarded in July 1888, at the Normal School of Science and Royal School of Mines, South Kensington, for the session 1887–88:—

First Year's Scholarships: Samuel H. Studley, Sydney Wood, William S. Jarratt, and George N. Huntly. Second Year's Scholarships: Savannah J. Speak and William Tate.

Edward Forbes Medal and Prize of Books for Biology: Arthur M. Davies. Murchison Prize of Books for Geology: William Tate and Samuel Truscott. The Murchison Medal was not awarded. Tyndall Prize of Books for Physics: William Watson. De la Beche Medal for Mining: Edmund L. Hope. Bessemer Medal and Prize of Books for Metallurgy: Harry C. Jenkins. Frank Hatton Prize of Books for Chemistry: James W. Rodger.

Prizes of Books given by the Science and Art Department:—Mechanics, James Whitaker; Astronomical Physics, William S. Jarratt and William Watson; Practical Chemistry, James W. Rodger and James Young; Mining, John M. Beckwith. The prize for Principles of Agriculture and Agricultural Chemistry was not awarded.

Associateships (Normal School of Science):—Mechanics, 1st Class: James Whitaker and William Kelsall. Physics, 1st Class: Harry E. Hadley and Philip L. Gray; 2nd Class: Herbert Anderson and Philip L. Coultas. Chemistry, 1st Class: James W. Rodger, James Young, Barker North, and Harold E. Hey; 2nd Class: William MacDonald, George Grace, Francis J. Hardy, George C. McMurtry, and Henry Sowerbulls. Biology, 1st Class: Arthur M. Davies. Geology, 1st Class: Thomas H. Holland.

Associateships (Royal School of Mines):—Metallurgy, 1st Class: Harry C. Jenkins, Thomas Clarkson, and William McNiell; 2nd Class: Alfred Howard. Mining, 1st Class: Edmund L. Hope, John M. Beckwith, James A. Chalmers, William F. Thomas, Sydney Allingham, Charles G. Thompson, John Leechman, Frederick H. P. Creswell, Ernest Lichtenburg; 2nd Class: Ferdinand F. L. Dielyrch, Henry L. Lewis, Henry B. Budgett, William F. Hamley, and Harold Macandrew.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 26.—"On the Coagulation of the Blood." Preliminary Communication. By W. D. Halliburton, M.D., B.Sc., Assistant Professor of Physiology, University College, London. Communicated by Prof. E. A. Schäfer, F.R.S. (From the Physiological Laboratory, University College, London.)

The present research was directed to determining the nature of the ferment that produces the change of fibrinogen into fibrin.

Some preliminary experiments showed that the following proteids were present in lymph cells (obtained from lymphatic glands).

(1) A mucin-like proteid similar to that described by Miescher in pus which swells up into a jelly-like substance when mixed with solutions of sodium chloride or magnesium sulphate. This is a nucleo-albumin.

(2) Two globulins.

(3) An albumin.

The Globulins.—There is a small quantity of a globulin which

enters into the condition of a heat coagulum at about 50° C. The most abundant globulin is, however, one which resembles serum globulin in its heat coagulation temperature (75° C.), and in the way in which it is precipitated by saturation with salts, or by dialyzing out the salts from its solutions.

The term serum globulin is hardly applicable to a proteid existing in lymph cells; hence it is necessary to multiply terms, and to designate this globulin by a new name, viz. *cell globulin*. It has, moreover, certain characteristic properties which will be fully dealt with later on.

The Albumin resembles serum albumin in its properties. It coagulates at 73° C. It is present in very small quantities. It may be provisionally termed *cell albumin*.

Having thus recognized the various proteids that occur in the cells of lymphatic glands, my next endeavour was to ascertain what action, if any, these exerted on the coagulation of the blood. My experiments in this direction have been mostly performed with salted plasma. The blood is received into an approximately equal volume of saturated sodium sulphate solution. By this means coagulation is prevented, and the corpuscles settle. On subsequently removing the supernatant salted plasma, and diluting it with four or five times its bulk of water, coagulation occurs after the lapse usually of several hours; but if, instead of water, a solution of fibrin ferment be used, coagulation occurs in a few minutes.

I first tried to prepare fibrin ferment from the lymphatic glands; these were freed from blood, chopped small, and placed under absolute alcohol for some months; they were then dried over sulphuric acid, powdered, and the dry powder extracted with water. The water was found to contain the fibrin ferment. It hastened very considerably the coagulation of salted plasma. This activity was destroyed at a temperature between 74° C. and 80° C. The watery extract gave, moreover, the xanthoproteic reaction; it contained also some sodium chloride and phosphates which it had dissolved out of the dried glands.

A watery or saline extract of fresh glands also had very considerable clotting powers; that is to say, the addition of a few drops of such an extract caused diluted salted plasma to clot in a few minutes, which otherwise did not clot until after the lapse of 12–24 hours. The activity of this extract was not altered by heating to 70°; it was therefore independent of the nucleo-albumin which is disintegrated at about 50° C., or of the globulin which coagulates at that temperature. Its activity was destroyed, however, if heated above 75° C. These facts show that the extracts of both dried and fresh glands contain a substance which has the same properties as fibrin ferment, and which, moreover, is rendered inactive at the temperature at which fibrin ferment, as ordinarily prepared from serum, loses its activity.

The next question which I investigated was whether the ferment action was dependent upon, or independent of, the presence of the proteids of the cells. An extract of the cells was made with sodium sulphate solution, and saturated with ammonium sulphate; the precipitate of the proteids so produced was filtered off; the proteid-free filtrate dialyzed till free from excess of salt, and it was then found to have no power of hastening coagulation. The precipitate which contained all the proteids was washed by saturated solution of ammonium sulphate, and redissolved by adding distilled water; this solution hastened the coagulation of salted plasma very considerably. This experiment showed either that the ferment was identical with or precipitated with the proteids in the extract. It was, moreover, destroyed at a temperature at which these proteids were coagulated, viz. about 75° C.; there are, however, in the solution two proteids which are coagulated at about this temperature, viz. the cell globulin and the cell albumin. The globulin and the albumin were then separated from one another, and it was found that the globulin and not the albumin had the properties of fibrin ferment.

After I had performed the experiments just related, the question naturally arose, Is this cell globulin the same thing as what has been termed fibrin ferment when prepared from serum? From the experiments which were performed in order to elucidate this question the following conclusions were drawn:—

(1) Lymph cells yield as one of their disintegration products a globulin which may be called cell globulin. This has the properties that have hitherto been ascribed to fibrin ferment.

(2) Fibrin ferment as extracted from the dried alcoholic precipitate of blood serum is found on concentration to be a globulin with the properties of cell globulin.

(3) The fibrin ferment as extracted by saline solutions from "washed blood clot" is a globulin which is also identical with cell globulin.

(4) Serum globulin as prepared from hydrocele fluid has no fibrinoplastic properties. It may perhaps be better termed plasma globulin.

(5) Serum globulin as prepared from serum has marked fibrinoplastic properties. This is because it consists of plasma globulin, and cell globulin derived from the disintegration of white blood corpuscles, which are in origin lymph cells.

(6) The cause of coagulation of the blood is primarily the disintegration of the white blood corpuscles; they liberate cell globulin, which acts as a ferment converting fibrinogen into fibrin. It does not apparently become a constituent part of the fibrin formed.

This confirmation and amplification of Hammarsten's views concerning the cause of the coagulation of the blood is in direct opposition to the theories of Wooldridge, which may be stated as follows:—The coagulation of the blood is a phenomenon essentially similar to crystallization; in the plasma there are three constituents concerned in coagulation, A, B, and C fibrinogen. A and B fibrinogen are compounds of lecithin and proteid, and fibrin results from the transference of the lecithin from A fibrinogen to B fibrinogen. C fibrinogen is what has hitherto been called fibrinogen; A fibrinogen is a substance which may be precipitated by cooling "peptone plasma," and on the removal of this substance coagulation occurs with great difficulty. The precipitate produced by cold consists of rounded bodies resembling the blood-plates in appearance. He further found that other compounds of lecithin and proteid, to which he has extended the name of fibrinogen, exist in the thymus and other organs, in the fluid of lymph glands, and in the stromata of red corpuscles; these substances may be extracted from the organs by water, and precipitated from the aqueous extract by acetic acid, and on redissolving this in a saline solution, and injecting it into the circulation of a living animal, intravascular clotting occurs which results in the death of the animal. This form of fibrinogen (?) that acts thus he looks upon as the precursor of A fibrinogen. From these points of view the fibrin ferment and the white corpuscles are looked upon as of secondary import in causing coagulation, though it is admitted that fibrin ferment converts C fibrinogen into fibrin.

The Influence of Lecithin in the Coagulation of the Blood.—Lecithin hastens the coagulation of blood-plasma, which has been prevented from clotting by the injection into the circulation of a certain quantity of commercial peptone; but peptone plasma, as I shall show more fully in the next section, differs so much from normal plasma, that it is impossible to draw correct conclusions from experiments performed with it, unless they be supported by confirmatory evidence on solutions of fibrinogen and pure plasma, such as one obtains from a vein, or from the pericardial sac, and lecithin does not cause coagulation in such cases.

The supposition that "fibrinogen A" acts by giving up its lecithin to "fibrinogen B" to form fibrin, seems, therefore, to be a pure assumption, and is unsupported by analytical evidence. Cell globulin contains no phosphorus, and can therefore contain no lecithin.

The Precipitate produced by cooling Peptone Plasma.—The chief point I wish to urge is that this precipitate is obtained on cooling peptone plasma only, and from no other form of plasma. I have repeatedly attempted to obtain such a precipitate by cooling to 0° C. pure plasma from the veins of the horse, salted plasma, hydrocele fluid, and pericardial fluid, but in all cases with a negative result. It therefore occurs in peptone plasma alone; and that it is due to the peptone is supported by the fact that if one takes an aqueous solution of "Witte's peptone" and cools it to 0° C., a precipitate is formed consisting of rounded granules very similar to blood-tablets. This precipitate moreover consists of hetero-albumose. (Witte's peptone contains a large admixture of albumose.) That peptone blood does differ in one other important particular from normal blood, viz. in the heat coagulation temperatures of its proteids, was shown by Wooldridge himself. It is on these grounds, then, that I hold we cannot regard peptone plasma as being at all comparable to normal plasma.

Intravascular Coagulation.—No doubt the crude and impure substance introduced into the veins produces intravascular clotting; but I must protest against the extension of the name fibrinogen to such substances. It seems to me it would be just as

correct to call a piece of iron wire introduced into the sac of an aneurysm to produce coagulation there, a fibrinogen.

With regard, however, to these tissue-fibrinogens of Wooldridge, I think we may venture to offer a suggestion as to their real nature, or, at any rate, as to the nature of one of their constituents. From the last paper published by Wooldridge, we find that they are imperfectly soluble in water, readily precipitated by acids, and soluble in excess of those reagents; that they yield on gastric digestion a substance which is insoluble and which is rich in phosphorus. From these details of their properties, I think we may draw the conclusion, not that they contain lecithin, as Wooldridge affirms, but that they belong to the group of proteids described in the former part of this paper under Hammarsten's name of nucleo-albumin. Nucleo-albumins yield when poured into water a stringy precipitate resembling mucin, and in a former paper Wooldridge speaks of the precipitate of his tissue fibrinogen (precipitated by acetic acid) as being a bulky one. If my conjecture is correct, it would be exceedingly likely that when a saline solution of such a substance was injected into the circulation, it would form strings of a slimy mucinoid description in the vessels, and that these would form the starting-point for the thrombosis or intravascular coagulation that ensues.

May 3.—"On the Induction of Electric Currents in Conducting Shells of Small Thickness." By S. H. Burbury.

(1) *Definition and Explanation of the Notation employed.*—A *current-sheet* in any field of electric currents is a surface to which the stream-lines are everywhere tangential. A *current-shell* is the space between two current-sheets very near each other. The *superficial current* in a current-shell is the quantity of electricity which in unit time crosses unit length of a line drawn on either sheet perpendicular to the current. If U, V, W be the components of superficial current, there always exists a function, ϕ, called *the current function*, such that—

$$U = n\frac{d\phi}{dy} - m\frac{d\phi}{dz}, \text{ \&c.,}$$

l, m, n being the direction cosines of the normal. This function completely determines the superficial currents.

The corresponding expressions for the component currents per unit of area are—

$$u = \frac{dS}{dz}\frac{d\Phi}{dy} - \frac{dS}{dy}\frac{d\Phi}{dz}, \text{ \&c.,}$$

where S and Φ are any two functions of x, y, and z.

The components of *vector potential* due to a current-sheet are—

$$F = \iint \frac{U}{r}dS = \iint \frac{1}{r}\left(n\frac{d\phi}{dy} - m\frac{d\phi}{dz}\right)dS.$$

And if the sheet be closed, this may be put in the form—

$$F = \iint \phi\left(m\frac{d}{dz} - n\frac{d}{dy}\right)\frac{1}{r}\,dS\,;\ G = \text{\&c.}$$

So that F, G, and H are linear functions of the ϕ's with coefficient functions of the co-ordinates.

If the current-sheet be spherical, the vector potential is tangential to any concentric spherical surface.

The *electro-kinetic energy* of a system of current-sheets is—

$$2T = \iiint (FU + GV + HW)\,dS$$

over all the sheets; that is—

$$\iiint \left(\phi\left(m\frac{dF}{dz} - n\frac{dF}{dy}\right)\text{\&c.}\right)dS,$$

if the surfaces be closed; and if Ω be the magnetic potential, this reduces to—

$$-\iint \phi\frac{d\Omega}{d\nu}\,dS,$$

$\frac{d\Omega}{d\nu}$ denoting the space variation of Ω per unit length of the normal measured outwards. Also, $\frac{d\Omega}{d\nu}$ is shown not to be discontinuous in passing through a sheet of superficial currents. T is expressible as a quadratic function of the ϕ's with coefficients functions of the co-ordinates.

(2) *Comparison with Magnetic Shells.*—The components of vector potential due to a magnetic shell placed on a closed surface, S, with variable strength, ϕ (reckoned as positive when the positive face is outwards), are—

$$F = \iint \phi\left(m\frac{d}{dz} - n\frac{d}{dy}\right)\frac{1}{r}\,dS.$$

They are, then, the same as those due to a system of currents on S determined by ϕ as current function. Hence the magnetic induction due to the magnetic shell is the same as that due to the corresponding system of currents at any point in free space.

(3) If Ω_0 denote the magnetic potential due to any magnetic system outside of S, it is possible to determine ϕ so that a shell of strength ϕ on S has, at all points on or within S, potential equal and opposite to Ω_0. General determination of ϕ to satisfy this condition. The solution is unique.

(4) Therefore, also, there exists a system of currents on S, having ϕ for current function, such that the magnetic force due to it is equal and opposite to that due to the external system at all points on or within S. This system is called the *magnetic screen* on S to the external system. Example of a sphere.

(5) *General Solution of the Problem of Induction, Resistance not being yet taken into account.*—If S_0, Ω_0, ϕ_0, &c., relate to a magnetic system outside of S, Ω and ϕ to S and superficial currents upon it, the whole electro-kinetic energy is—

$$\iint \phi_0\left(\frac{d\Omega_0}{d\nu} + \frac{d\Omega}{d\nu}\right)dS_0$$
$$+\iint \phi\left(\frac{d\Omega_0}{d\nu} + \frac{d\Omega}{d\nu}\right)dS.$$

In this form, T has as many variables—namely, the values of ϕ—as it has degrees of freedom.

If, therefore, the external system be continuously varied, the induced current on S will be given by

$$\frac{d}{dt}\frac{dT}{d\phi} = 0 \text{ on S,}$$

that is,

$$\frac{d}{dt}\left(\frac{d\Omega_0}{d\nu} + \frac{d\Omega}{d\nu}\right) = 0 \text{ on S,}$$

that is,

$$\frac{d}{d\nu}\left(\frac{d\Omega_0}{dt} + \frac{d\Omega}{dt}\right) = 0 \text{ on S.}$$

And since $\nabla^2\frac{d\Omega_0}{dt} = 0$, and $\nabla^2\frac{d\Omega}{dt} = 0$ at all points within S it follows that $\frac{d\Omega_0}{dt} + \frac{d\Omega}{dt} = 0$ at all points within S.

That is, the induced currents, on their creation, are the *magnetic screen* to the time variation of the external field. This gives the law of formation of the currents, however rapidly they may decay by resistance.

(6) *Of a Solid Conductor.*—If S be a hollow shell, there will, as the direct result of induction, be zero magnetic force at all points within it. Therefore, if it be filled with conducting matter so as to form a solid conductor, none but superficial currents will, as the direct consequence of the variation of the external field, be induced in it. But as the superficial currents decay by resistance, their variation induces currents in the inner strata of the solid, so that in time, and no doubt generally in a very short time, the solid becomes pervaded by currents. The currents penetrate the solid, and the initial *rate of penetration* can be calculated under certain conditions (see *post*, 15).

(7) *Of the Associated Function.*—If F, G, H be the components of any vector which satisfy

$$\frac{dF}{dx} + \frac{dG}{dy} + \frac{dH}{dz} = 0$$

at all points within a closed surface, S, there exists a function, χ, called the *associated function*, such that—

$$\frac{d\chi}{d\nu} = lF + mG + nH \text{ on S,}$$
$$\nabla^2\chi = 0 \text{ within S.}$$

The components F, G, H of vector potential of a system of closed currents outside of S have an associated function, χ, on S. In like manner $-\frac{dF}{dt}$, $-\frac{dG}{dt}$, and $-\frac{dH}{dt}$ have an associated function, which shall be denoted by ψ.

(8) If $\frac{dF}{dt}$, $\frac{dG}{dt}$, and $\frac{dH}{dt}$ relate to an external system and its magnetic screen on S, we have

$$\frac{d}{dt}\frac{dF}{dy} = \frac{d}{dt}\frac{dG}{dx}, \text{ \&c., within S,}$$

whence it follows that

$$-\frac{dF}{dt} = \frac{d\psi}{dx}, \; -\frac{dG}{dt} = \frac{d\psi}{dy}, \text{ \&c.}$$

If, therefore,

$$-\frac{dF}{dt}, \; -\frac{dG}{dt}, \; -\frac{dH}{dt}$$

are the components of an *electromotive force* within S, there will form on S a distribution of statical electricity having potential ψ, and forming a complete *electric screen* to the external system.

(9) *Of Self-inductive Systems of Currents on a Surface.*—If any system of currents in a conducting shell be left to decay by resistance, uninfluenced by any external induction, it may be the case that they decay proportionally; so that, if U_0, V_0, W_0 denote the initial values of the component currents, their values at time t are $U = U_0\epsilon^{-\lambda t}$, $V = V_0\epsilon^{-\lambda t}$, $W = W_0\epsilon^{-\lambda t}$, and $\frac{dU}{dt} = -\lambda U$, &c., where λ is a constant proportional to the specific resistance, and inversely proportional to the absolute thickness. If this be the case, the system is defined to be *self-inductive*.

(10) By Ohm's law we have, whether the system be self-inductive or not,—

$$\sigma u = -\frac{dF}{dt} - \frac{d\psi}{dx}, \text{ \&c.,}$$

where u is the component current per unit of area, and σ the specific resistance.

If h be the thickness of the shell, $\sigma u = \frac{\sigma}{h}U$, and the equations may be written—

$$\frac{\sigma}{h} = \frac{-\frac{dF}{dt} - \frac{d\psi}{dx}}{U} = \frac{-\frac{dG}{dt} - \frac{d\psi}{dy}}{V}, \text{ \&c.}$$

If the system be self-inductive $-\frac{dF}{dt} = \lambda F$, &c., and $-\frac{d\psi}{dx} = \lambda\chi$, where χ is the associated function to F, G, and H, and ψ to $-\frac{dF}{dt}$, $-\frac{dG}{dt}$, and $-\frac{dH}{dt}$. Therefore—

$$\frac{\sigma}{h} = \lambda\frac{F + \frac{d\chi}{dz}}{U} = \lambda\frac{G + \frac{d\chi}{dy}}{V} = \lambda\frac{H + \frac{d\chi}{dz}}{W}.$$

(11) Now if we assume as current function on S any arbitrary function, ϕ, we thereby determine U, V, W, and therefore also F, G, H, and χ, at all points on S. It will not be generally true that—

$$\frac{F + \frac{d\chi}{dx}}{U} = \frac{G + \frac{d\chi}{dy}}{U} = \frac{H + \frac{d\chi}{dz}}{W}.$$

These equations constitute a condition which the current function ϕ must satisfy in order that the system may be capable of being made self-inductive. Their geometrical interpretation is that the tangential component of vector potential of the currents in the sheet coincide with the current at every point.

If ϕ be chosen to satisfy that condition, then by the equation—

$$\frac{\sigma}{h} = \lambda\frac{F + \frac{d\chi}{dx}}{U} = \lambda Q \text{ (suppose)}$$

we determine h, the thickness of the shell at every point, necessary to make the shell self-inductive, *i.e.* $h = \frac{\sigma}{\lambda Q}$.

(12) *Examples of Self-inductive Systems.*—1. S a sphere, and ϕ any spherical surface harmonic of one order. Here h is a constant.

2. S a surface of revolution about the axis of z, and ϕ a function of z only.

3. Any surface, with ϕ a function of z only, if χ is independent of z. Example: an ellipsoid whose axes are the axes of co-ordinates, and $\phi = Az$. It is found in this case that $\psi \propto xy$, and therefore the necessary condition for a self-inductive system is satisfied; and also, to make it self-inductive, h varies as the perpendicular from the centre on the tangent plane at the point.

(13) *Co-existence of Self-inductive Systems.*—If any number of self-inductive systems be created in the same shell, each decays according to its own law, unaffected by the others. If all have the same value of λ, then, as the effect of resistance apart from induction, we have

$$\frac{d\Omega}{dt} + \lambda\Omega = 0,$$

where Ω is the magnetic potential of the whole system.

(14) *General Property of Self-inductive Systems.*—If an external system so vary as that the system of currents in the shell S, induced at any instant, shall always be self-inductive, and with the same value of λ, we have, to determine the currents in the shell at any instant, the equation—

$$\frac{d\Omega_0}{dt} + \frac{d\Omega}{dt} + \lambda\Omega = 0,$$

from which Ω can be found, if $\frac{d\Omega_0}{dt}$ is given.

Example 1.—Let $\frac{d\Omega_0}{dt} = C$, a constant. In this case we find $\Omega = \frac{C}{\lambda}\left(1 - \epsilon^{-\lambda t}\right)$. If C be very great, and t very small, this approximates to the ideal case of an impulsive force, and Ω becomes equal to Ct, and is independent of the resistance. If, on the other hand, λt be very great, we have $\Omega = \frac{C}{\lambda}$, and Ω varies inversely as the resistance.

Example 2.—Let $\Omega_0 = A\cos kt$, where k is constant, and A independent of the time, but a function of position. This leads to the result—

$$\Omega = -A\sin\alpha\sin\overline{kt - \alpha},$$

$$\Omega_0 + \Omega = A\cos\alpha\cos\overline{kt - \alpha},$$

at all internal points. Here, α is *the retardation of phase*, and is equal to $\cot^{-1}\frac{\sigma}{Qhk}$.

For instance, if S is a sphere of radius a, and $\phi = A\cos kt$, $Q = \frac{2n + 1}{4\pi a}$, and the result obtained agrees with that given by Prof. Larmor in *Phil. Mag.*, January 1884.

(15) If the shell be infinitely thin—

$$\alpha = \sin\alpha = \frac{Qhk}{\sigma},$$

the same phase is reached in the inner field at a time later by $\frac{\alpha}{k}$, that is, $\frac{Qh}{\sigma}$, than in the outer field. The ratio which in the limit h bears to this difference of time is $\frac{\sigma}{Q}$, and is, in case of a solid conductor, the initial *velocity* with which the currents penetrate the solid.

(16) If S be any homogeneous function of positive degree in x, y, and z, the space within S = 0 may be conceived as divided into a number of concentric similar and similarly situated shells, each between two surfaces of the type S = c and S = $c + dc$. Let ϕ be a function, which, as current function, gives a self-inductive system of currents in each shell of the series, if made a conductor. Let an outer shell of the series be described on S, and an inner shell of the series on S′. Let currents of the type ϕ be generated in the shell S. Let u, v, w be the functions—

$$u = \frac{dS}{dz}\frac{d\phi}{dy} - \frac{dS}{dy}\frac{d\phi}{dz}, \text{ \&c.}$$

Then u, v, w may be the components per unit of area of a system of currents in the shell S. And since this system is self-inductive,—

$$\sigma u = \lambda\left(F + \frac{d\chi}{dx}\right) \text{ on S.}$$

Now $\nabla^2 F = 0$, and $\nabla^2\chi = 0$ at all points within S.

If, therefore, $\nabla^2 u = 0$ at all points within S,

$$\sigma u = \lambda\left(F + \frac{d\chi}{dx}\right) \text{ at all points within S.}$$

That is,

$$\sigma u = -\frac{dF}{dt} - \frac{d\psi}{dx}, \text{ \&c., on S}'.$$

Therefore the creation of the given system of currents on S acts as an electromotive force tending to produce the currents u, v, w with reversed signs on S′. And since this system of currents in S′ is self-inductive, it will be actually generated by induction. As an example, if

$$S = \frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2}$$

and $\phi = Az$,

$$u = \frac{dS}{dz}\frac{d\phi}{dy} - \frac{dS}{dy}\frac{d\phi}{dz} = -2A\frac{y}{b^2};$$

and therefore $\nabla^2 u = 0$.

It follows that the creation in an ellipsoidal shell of thickness proportional to the perpendicular from the centre on the tangent plane of a system of currents of the type $\phi = Az$ generates by induction the corresponding system of currents with reversed sign in an inner concentric similar and similarly situated ellipsoidal shell.

(17) *Case of an Infinite Plane: Arago's Disk.*—In this case, if the shell be of uniform thickness, a system of currents in it will not be generally self-inductive, but admits, nevertheless, of mathematical treatment. Suppose the plane to be fixed, and the field to revolve round an axis perpendicular to it, taken for that of z, with uniform angular velocity, ω.

Let γ be the normal force due to the field, γ' that due to the induced currents. Then we have, as the effect of induction,—

$$\frac{d\gamma}{dt} + \frac{d\gamma'}{dt} = 0.$$

As the effect of resistance—

$$\frac{d\gamma'}{dt} = \frac{\sigma}{2\pi}\frac{d\gamma'}{dz};$$

and, therefore, for the whole variation of γ'—

$$\frac{d\gamma}{dt} + \frac{d\gamma'}{dt} = \frac{\sigma}{2\pi}\frac{d\gamma'}{dz}.$$

When the motion is steady—

$$\frac{d\gamma}{dt} = \omega\frac{d\gamma}{d\theta}, \quad \frac{d\gamma'}{dt} = \omega\frac{d\gamma'}{d\theta},$$

θ being the angle through which the field has turned. Hence—

$$\omega\left(\frac{d\gamma}{d\theta} + \frac{d\gamma'}{d\theta}\right) = \frac{\sigma}{2\pi}\frac{d\gamma'}{dz},$$

a result which agrees with Maxwell's (23) of Art. 699.

June 21.—"Effects of Different Positive Metals, &c., upon the Changes of Potential of Voltaic Couples." By Dr. G. Gore, F.R.S.

In this research numerous measurements were made, and are given in a series of tables, of the effects upon the minimum-point of change of potential of a voltaic couple in distilled water (Roy. Soc. Proc., June 14, 1888), and upon the changes of electro-motive force attending variation of strength of its exciting liquid (*ibid.*), obtained by varying the kind of positive and of negative metal of the couple, and by employing different galvanometers. The measurements were made by the method of balance through a galvanometer, with the aid of a suitable thermo-electric pile (Birm. Phil. Soc. Proc., vol. iv. p. 130; *The Electrician*, 1884, vol. xi. p. 414). The kinds of galvanometer employed were, an ordinary astatic one of 100 ohms resistance, and a Thomson's reflecting one of 3040 ohms resistance.

The following were the proportions of hydrochloric acid (HCl), required to change the potential of different voltaic couples in water :—

TABLE I.—*Hydrochloric Acid.*

Astatic Galvanometer.				
Zn + Pt	between 1 in	9,300,000	and	9,388,185
Cd + Pt	,, 1 ,,	574,000	,,	637,000
Mg + Pt	,, 1 ,,	516,666	,,	574,000
Al + Pt	,, 1 ,,	12,109	,,	15,000
Reflecting Galvanometer.				
Zn + Pt	between 1 in	15,000,000	and	23,250,000
Cd + Pt	,, 1 ,,	1,162,500	,,	1,550,000
Mg + Pt	,, 1 ,,	775,000	,,	930,000
Al + Pt	,, 1 ,,	42,568	,,	46,500

With iodine and the astatic galvanometer the following proportions were required :—

TABLE II.—*Iodine.*

Zn + Pt	between 1 in	3,100,000	and	3,521,970
Mg + Pt	,, 1 ,,	577,711	,,	643,153
Cd + Pt	,, 1 ,,	2-0,431	,,	224,637

With bromine and the astatic galvanometer :—

TABLE III.—*Bromine.*

Mg + Pt	between 1 in	310,000,000	and	344,444,444
Zn + Pt	,, 1 ,,	77,500,000	,,	84,545,000
Cd + Pt	,, 1 ,,	3,470,112	,,	3,875,000

The magnitudes of the minimum proportions of bromine required to change the potentials of the three couples in water varied directly as the atomic weights of the three positive metals.

With chlorine the following were the minimum proportions required :—

TABLE IV.—*Chlorine.*

With the Reflecting Galvanometer.				
Mg + Pt	between 1 in	27,062,000,000	and	32,291,000,000
With the Astatic Galvanometer.				
Mg + Pt	between 1 in	17,000,000,000	and	17,612,000,000
Zn + Pt	,, 1 ,,	1,264,000,000	,,	1,300,000,000
Zn + Au	,, 1 ,,	518,587,360	,,	550,513,022
Cd + Pt	,, 1 ,,	8,733,585	,,	9,270,833
Zn + Cd	,, 1 ,,	55,436	,,	76,467

In the case of chlorine, as well as that of bromine, the magnitudes of the minimum proportions of substance required to change the potential of magnesium-platinum, zinc-platinum, and cadmium-platinum, varied directly as the atomic weights of the positive metals.

The examples contained in the paper show that the proportion of the same exciting liquid necessary to disturb the potential of a voltaic couple in water varied with each different positive or negative metal, and that the more positive or more easily corroded the positive metal, or the more negative and less easily corroded the negative one, the smaller usually was the minimum proportion of dissolved substance necessary to change the potential.

By plotting the results in all cases, it was found that the order of change of potential, caused by uniform change of strength of liquid, varied with each positive metal.

The results also show that the degree of sensitiveness of the arrangement for detecting the minimum-point of change of potential depends largely upon the kind of galvanometer employed.

As a more sensitive galvanometer enables us to detect a change of potential caused by a much smaller proportion of material, and as the proportion of substance capable of detection is smaller the greater the free chemical energy of each of the uniting bodies (Roy. Soc. Proc., June 14, 1888) it is probable that the electromotive force really begins to change with the very smallest addition of the substance, and might be detected if our means of detection were sufficiently sensitive, or the free chemical energy of the uniting bodies was sufficiently strong.

"The Voltaic Balance." By Dr. G. Gore, F.R.S.

A New and Simple Lecture Experiment.—Take two small clean glass cups containing distilled water ; simultaneously immerse in each a small voltaic couple, composed of either unamalgamated magnesium or zinc with platinum, taking care that the two pieces of each metal are cut from the same piece and are perfectly clean and alike. Oppose the currents of the two couples to each other through a sufficiently sensitive galvanometer, so that they balance each other and the needle does not move. Now dip the end of a slender glass rod into a very weak aqueous solution of chlorine, bromine, iodine, or hydrochloric acid, and then into the water of one of the cups. The voltaic balance is at once upset, as indicated by the measurement of the needle, and may be shown to a large audience by means of the usual contrivances.

The chief circumstance to be noticed is the extremely great degree of sensitiveness of the arrangement in certain cases. This is shown by the following instances of the minimum proportions of substance required to upset the balance with an ordinary astatic galvanometer, and with a Thomson's reflecting one of 3040 ohms resistance.

1. *Zinc and Platinum with Iodine.* — With the astatic galvanometer, between 1 part of iodine in 3,100,000 and 3,521,970 parts of water.

2. *Zinc and Platinum with Hydrochloric Acid.*—With the astatic galvanometer, between 1 in 9,300,000 and 9,388,185 parts; and with the reflecting one, between 1 in 15,500,000 and 23,250,000 parts.

3. *Magnesium and Platinum with Bromine.* — With the astatic galvanometer, between 1 in 310,000,000 and 344,444,444 parts.

4. *Zinc and Platinum with Chlorine.*—With the astatic galvanometer, between 1 in 1,264,000,000 and 1,300,000,000 parts.

5. *Magnesium and Platinum with Chlorine.*—With the astatic galvanometer, between 1 in 17,000,000,000 and 17,612,000,000 parts; and with the reflecting one, between 1 in 27,062,000,000 and 32,291,000,000 parts of water.

Every different soluble substance requires a different proportion, and with unlike substances the difference of proportion is extremely great. With solutions of neutral salts, the proportion of substance required to upset the balance is large; for instance, with chlorate of potash, a zinc-platinum couple, and the astatic galvanometer, it lay between 1 part in 221 and 258 parts of water.

The degree of sensitiveness of the balance is usually greater, the greater the degree of chemical affinity the dissolved substance has for the positive metal and the less it has for the negative one.

By first bringing the balance with a magnesium-platinum couple and the astatic galvanometer nearly to the upsetting-point by adding 1 part of chlorine to 17,612,000,000 parts of water, and then increasing the proportion to 1 in 17,000,000,000, the influence of the difference, or of 1 part in 500,000,000,000, was distinctly detected.

"Magnetic Qualities of Nickel." (Supplementary Paper.) By J. A. Ewing, F.R.S., Professor of Engineering in University College, Dundee.

The paper is a supplement to one with the same title by Prof. Ewing and Mr. G. C. Cowan, which was read at a recent meeting of the Society. It describes experiments, conducted under the author's direction by two of his students, Mr. W. Low and Mr. D. Low, on the effects of longitudinal compression on the magnetic permeability and retentiveness of nickel. The results are exhibited by means of curves, showing the relation which was determined between the intensity of magnetisation of the metal and the magnetising force, when a nickel bar, reduced to approximate endlessness by a massive iron yoke which formed a magnetic connexion between its ends, was magnetised under more or less stress of longitudinal compression. Corresponding curves show the relation of residual magnetism to magnetising force, for various amounts of stress; and others are drawn to show the relation of magnetic permeability to magnetic induction. Initial values of the permeability, under very feeble magnetising forces, were also determined. The experiments were concluded by an examination of the behaviour of nickel in magnetic fields of great strength. Magnetising forces ranging from 3000 to 13,000 C.G.S. units were applied by placing a short bobbin with a narrow neck made of nickel between the poles of a large electromagnet, and it was found that these produced a practical constant intensity of magnetisation which is to be accepted as the saturation value.

PARIS.

Astronomical Society, June 6.—M. Flammarion, President, in the chair.—Various drawings and observations were sent by MM. Petit, Rengel, and G. Vallet.—M. Flammarion read a paper on the solar eclipses of the 19th century, shewing strong discrepancies between M. Oppolzer's charts and the results of observation. Replying to M. Oppert, M. Flammarion said he should not advise historians to base their investigations on those charts.—M. M. Cornillon sent drawings of a large sunspot from May 11 to 23. M. Schmoll said that this spot was just on the limits of visibility to the naked eye from May 16 to 18.—M. Gaudibert sent a drawing of the lunar crater Flammarion. A fine rill traverses this crater, and extends to Réaumur after being interrupted by some hills.—M. Schmoll related an observation of the lunar crescent on May 12, the moon being 42½ hours old. Its breadth was from 30″ to 35″.—M. Trouvelot presented to the Society a series of celestial photographs offered by Prof. Pickering, of Harvard College. The photograph of the Pleiades is specially interesting, and shows the straight trails of nebulous matter which form such a striking feature in the last negatives obtained by MM. Henry.—Thanks were returned to Prof. Pickering, who was unanimously named honorary member of the Society on the proposition of M. Trouvelot and Colonel Laussedat.—Colonel Laussedat explained his method of computing solar eclipses graphically, which is two or three times more rapid than the usual numerical calculation.

AMSTERDAM.

Royal Academy of Sciences, June 30.—M. Beyerinck stated the results he has obtained from experiments on hybridism or crossings with common barley (*Hordeum vulgare, H. hexastichon, H. distichon, H. Zeocriton*, and *H. trifurcatum*, made by him since 1884 on a large scale, and illustrated his subject with specimens, some dried and others preserved in spirits. He described the precautions to be taken in such crossing experiments, and deduced the following conclusions:—(1) All the above-mentioned sorts of barley may be crossed with facility, indiscriminately. (2) The hybrids thus obtained are very perfectly self-fertile; those produced from *H. vulgare* (fem.) and *H. distichon* (m.), and those from *H. vulgare* (fem.) and *H. Zeocriton* (m.) even cleistogamous. (3) The hybrids of the first generation partake in general of a middle shape between the two parents. An exception to this rule was made by those of *H. nudum* (fem.) and *H. trifurcatum* (m.), a great part of which proved to belong to the not expected common intermediate form between *H. vulgare* and *H. distichon*. A few specimens belonged to the expected *cornutum* form. (4) The seedlings from hybrids obtained by self-fertilization are very various. The speaker obtained, besides a few already known ones, some quite new varieties. It was remarkable that the third generation of a cross between *H. vulgare* (fem.) and *H. Zeocriton* (m.) produced *H. hexastichon*. (5) In the present summer, a cross effected in 1884 between *H. distichon* (fem.) and *H. trifurcatum* (m.) produced a form almost completely without awns.—M. Fürbringer imparted the results of a research made by M. J. F. van Bemmelen into the origin of the fore-limbs and of the lingual muscles in reptiles.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Electric Lighting; Its Present Position and Future Prospects: Hammond and Co. (Whitehead, Morris, and Lowe).—A System for the Construction of Crystal Models on the Type of an Ordinary Plait: John Gorham (Spon).—An Introduction to the Science and Practice of Photography: Chapman Jones (Iliffe and Sons).—Religion and Science: W. Fitzgerald (Hodges, Figgis, and Co.).—A Practical Decimal System for Great Britain and her Colonies: R. T. Rohde (E. Wilson).—The Rothamsted Experiments on the Growth of Wheat, Barley, and the Mixed Herbage of Grass Land: Prof. W. Fream (Horace Cox).—Rock-Forming Minerals: Frank Rutley (T. Murby).—Smithsonian Report, 1885, Part 2 (Washington, U.S.)—The Glasgow and West of Scotland Technical College Calendar, 1888.

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